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Shimizu

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(45) **Date of Patent: Mar. 25, 2014**

(54) **TRANSFER DEVICE AND IMAGE FORMING APPARATUS INCORPORATING TRANSFER DEVICE**

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(73) Assignee: **Ricoh Company, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 348 days.

(21) Appl. No.: **13/158,073**

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Aug. 31, 2010 (JP) 2010-194913

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G03G 15/16 (2006.01)
G03G 15/01 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0136*** (2013.01); ***G03G 15/1675*** (2013.01)
USPC **399/66**

(58) **Field of Classification Search**
CPC G03G 15/1675; G03G 15/0136; G03G 15/0131
USPC 399/66, 313, 314
See application file for complete search history.

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Assistant Examiner — Rodney Bonnette
(74) *Attorney, Agent, or Firm* — Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

An image transfer system comprises an image bearer and an opposed member having a contact surface contacting a recording medium and opposed to a surface of the image bearer to form a transfer nip. A pressing device applies pressure to the transfer nip. An engaging and disengaging member engages and disengages the contact surface from the surface of the image bearer. A transfer bias device applies a transfer bias transferring an image formed on the image bearer onto the recording medium conveyed and pinched at the transfer nip. The image is composed of an adjustment pattern formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip. The engaging and disengaging device disengages the contact surface from the surface of the image bearer to form a gap therebetween when the adjustment pattern passes therethrough.

14 Claims, 14 Drawing Sheets

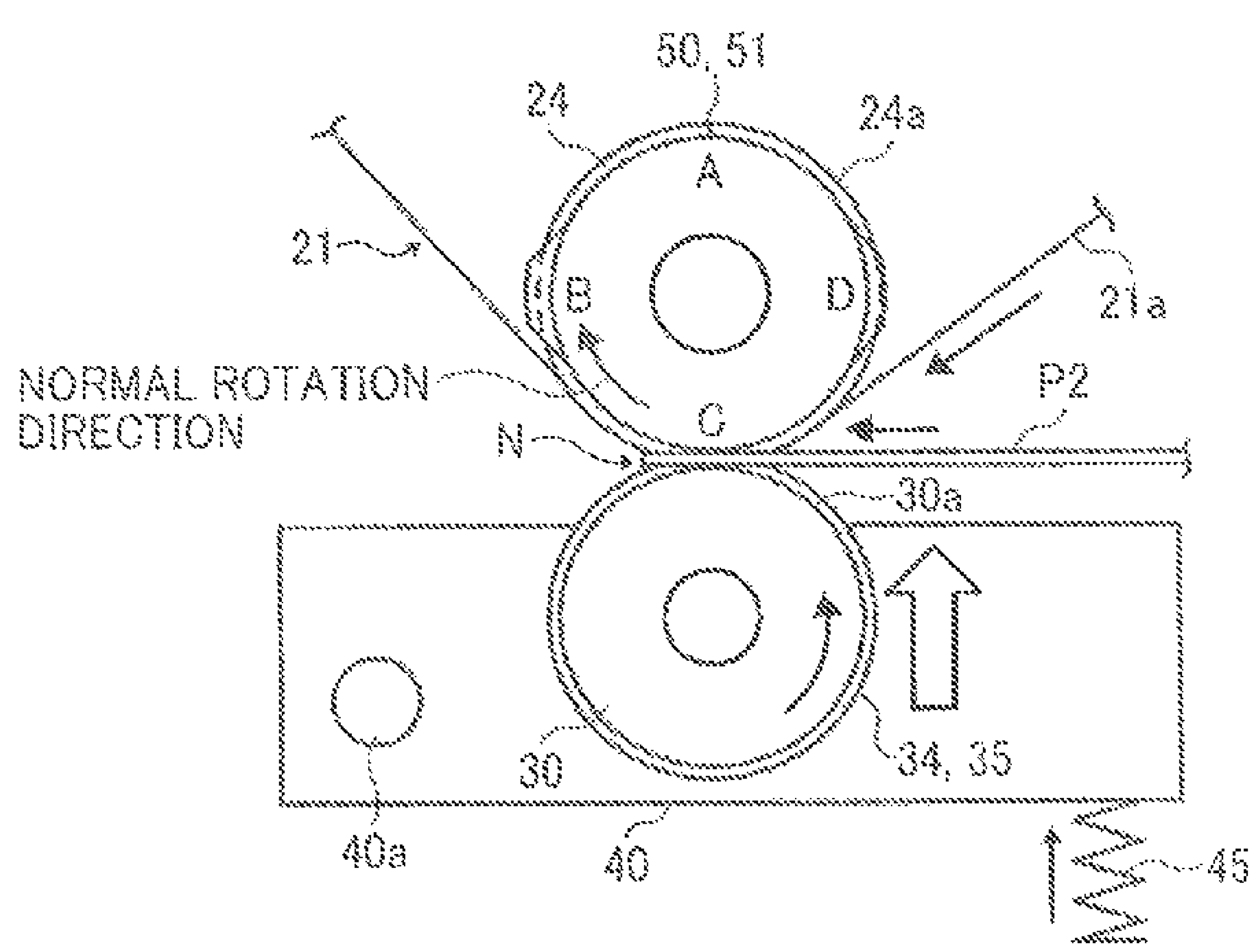

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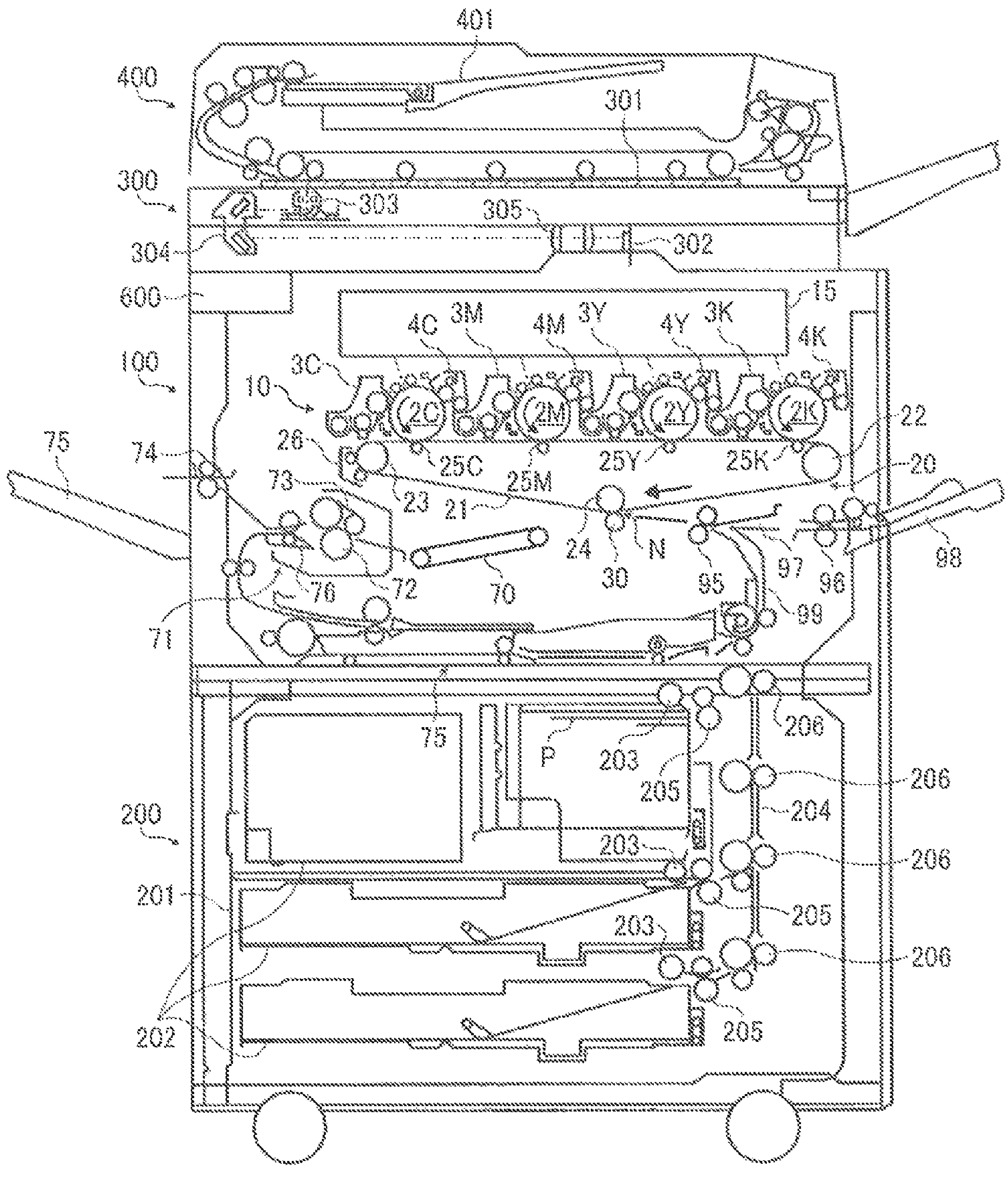
FIG. 1


401
400
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303
305
304
302
600
15
4C
3M
4M
3Y
4Y
3K
4K
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10
2C
2M
2Y
2K
22
26
25C
25M
25Y
25K
20
75
74
73
23
21
24
N
97
98
30
95
96
70
76
72
99
71
75
206
P
203
205
206
204
200
203
206
201
205
203
206
202
205

FIG. 2

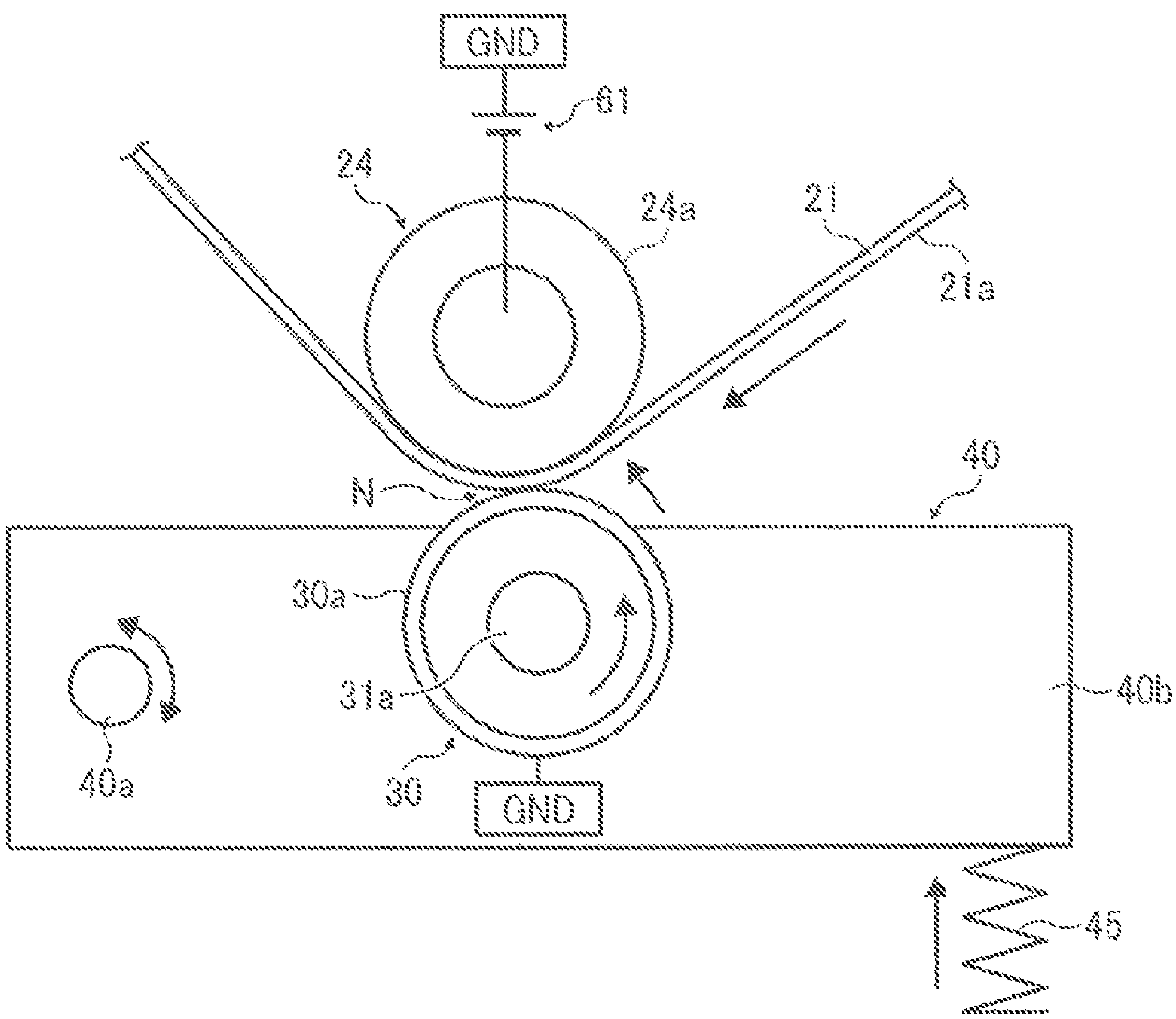
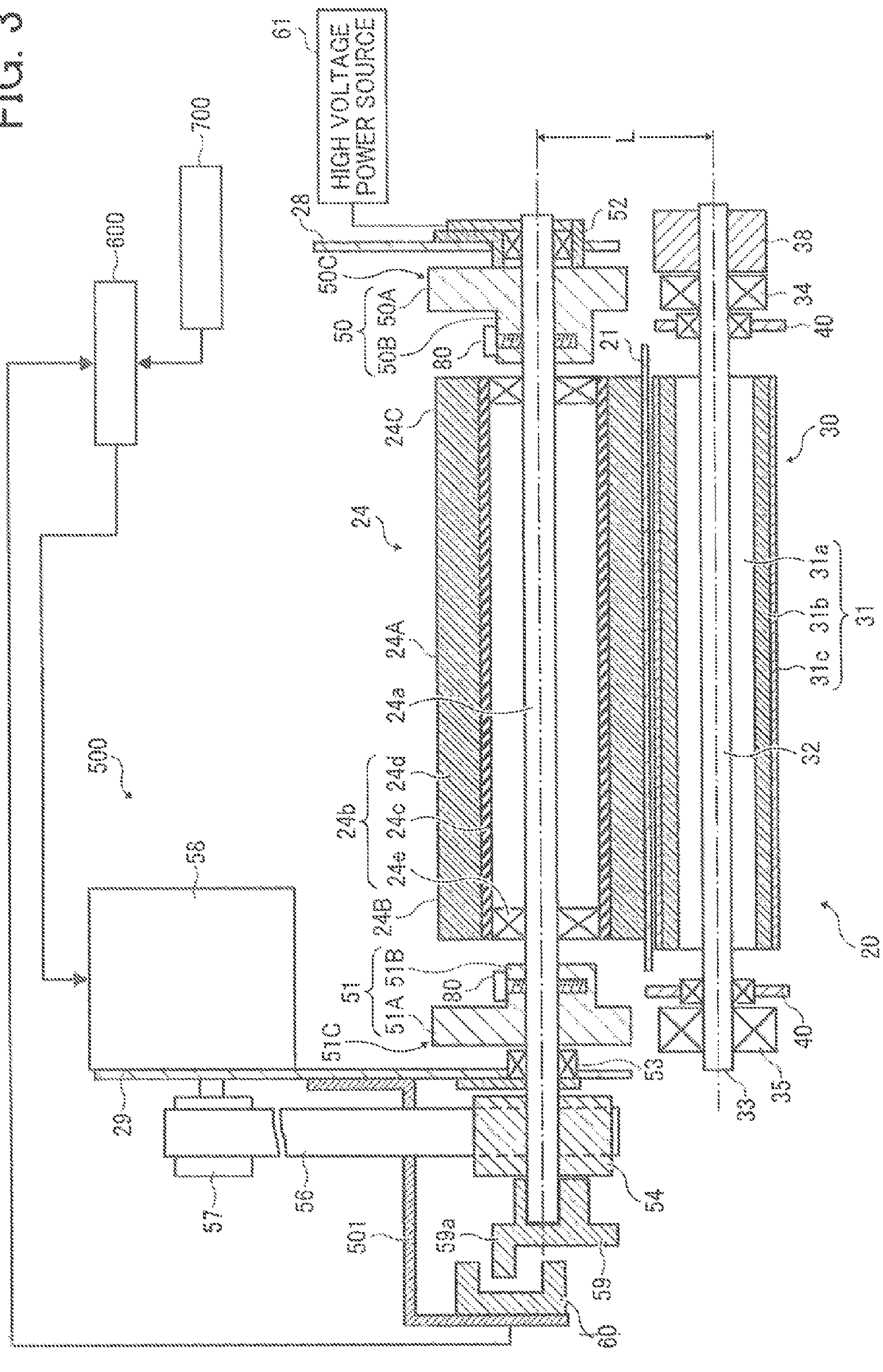


FIG. 3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POWER SOURCE
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600
500
58
29
57
56
501
59a
59
60
54
53
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35
40
20
51
51A
51B
51C
80
24B
24b
24e
24c
24d
24a
24A
24
24C
50
50A
50B
50C
28
52
38
34
21
30
31
31a
31b
31c
32
L

FIG. 4

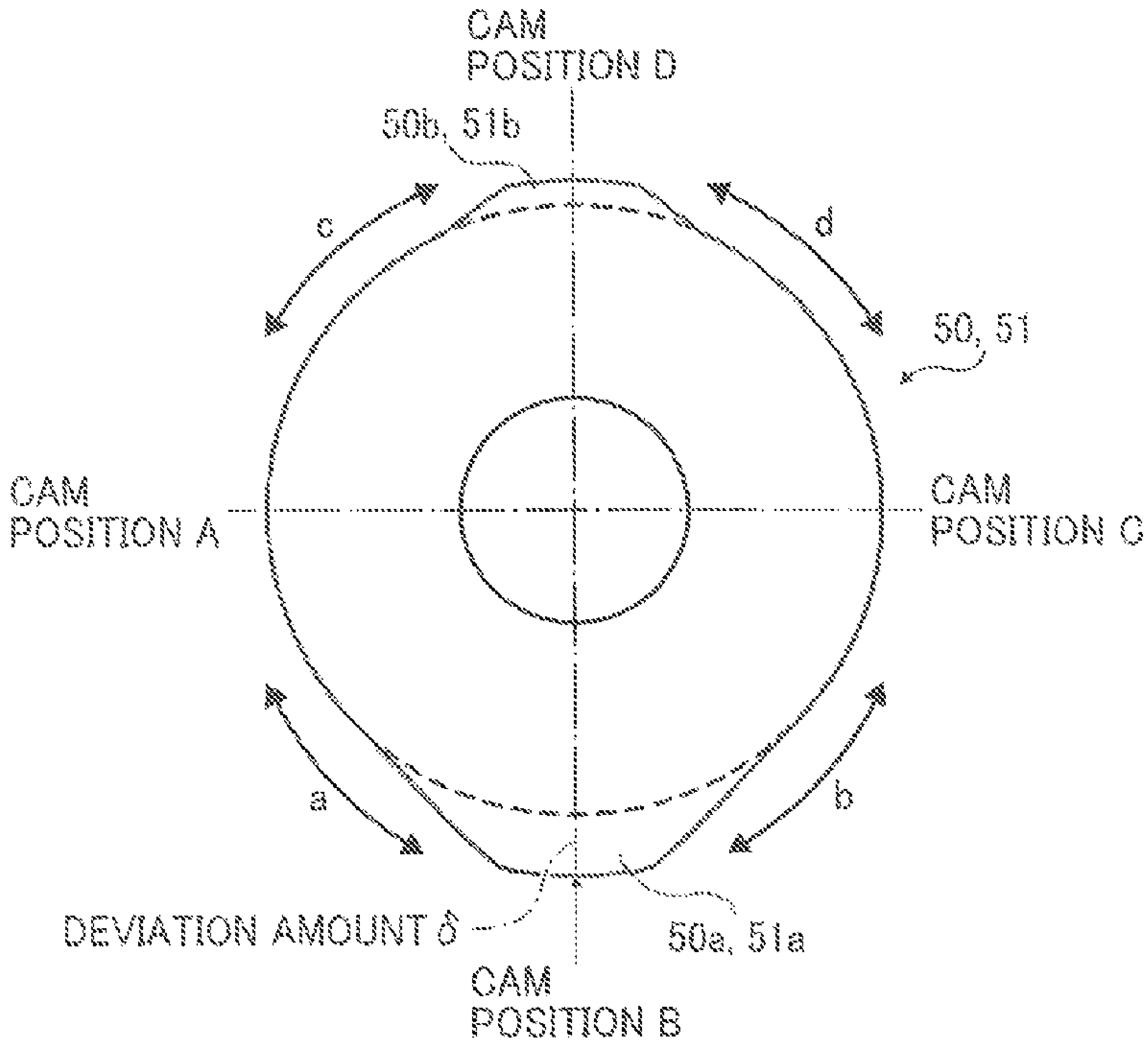

CAM
POSITION D
50b, 51b
c
d
50, 51
CAM
POSITION A
CAM
POSITION C
a
b
DEVIATION AMOUNT δ
50a, 51a
CAM
POSITION B

FIG. 5

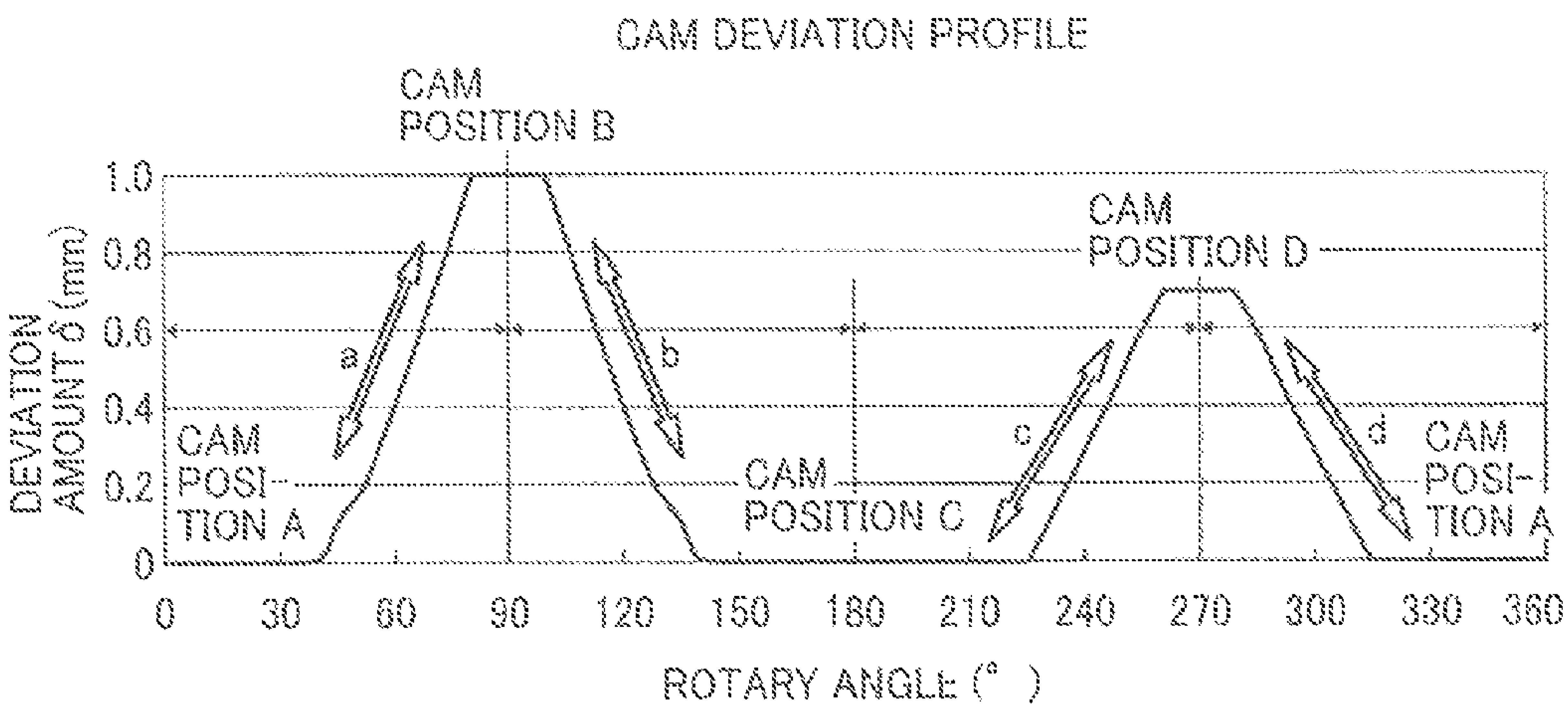

CAM DEVIATION PROFILE
CAM
POSITION B
CAM
POSITION D
CAM
POSITION C
CAM
POSI-
TION A
a
b
c
d
DEVIATION
AMOUNT δ (mm)
1.0
0.8
0.6
0.4
0.2
0
0 30 60 90 120 150 180 210 240 270 300 330 360
ROTARY ANGLE (°)

FIG. 6

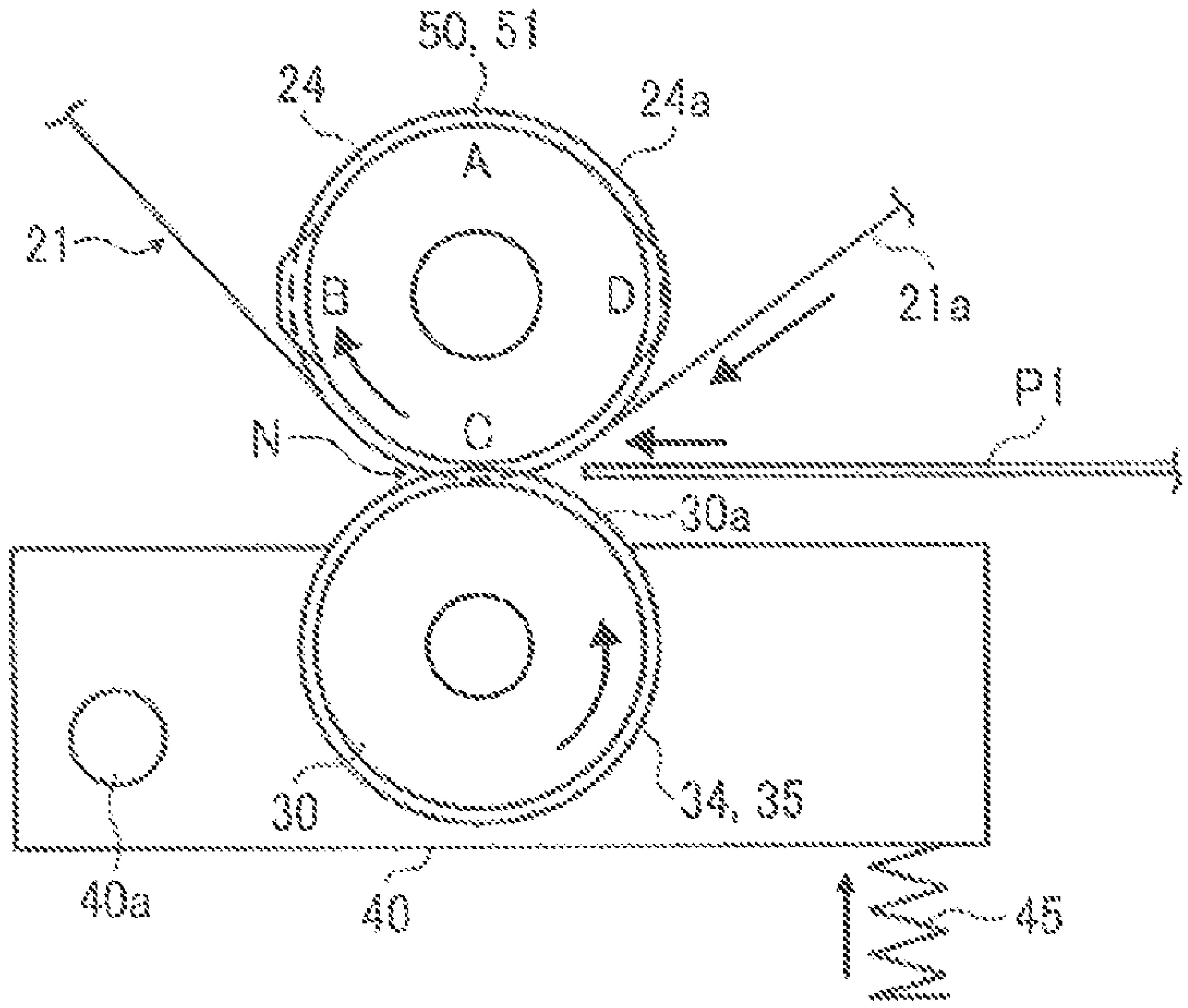

50, 51
24
24a
A
21
B
D
21a
N
C
P1
30a
30
34, 35
40a
40
45

FIG. 7

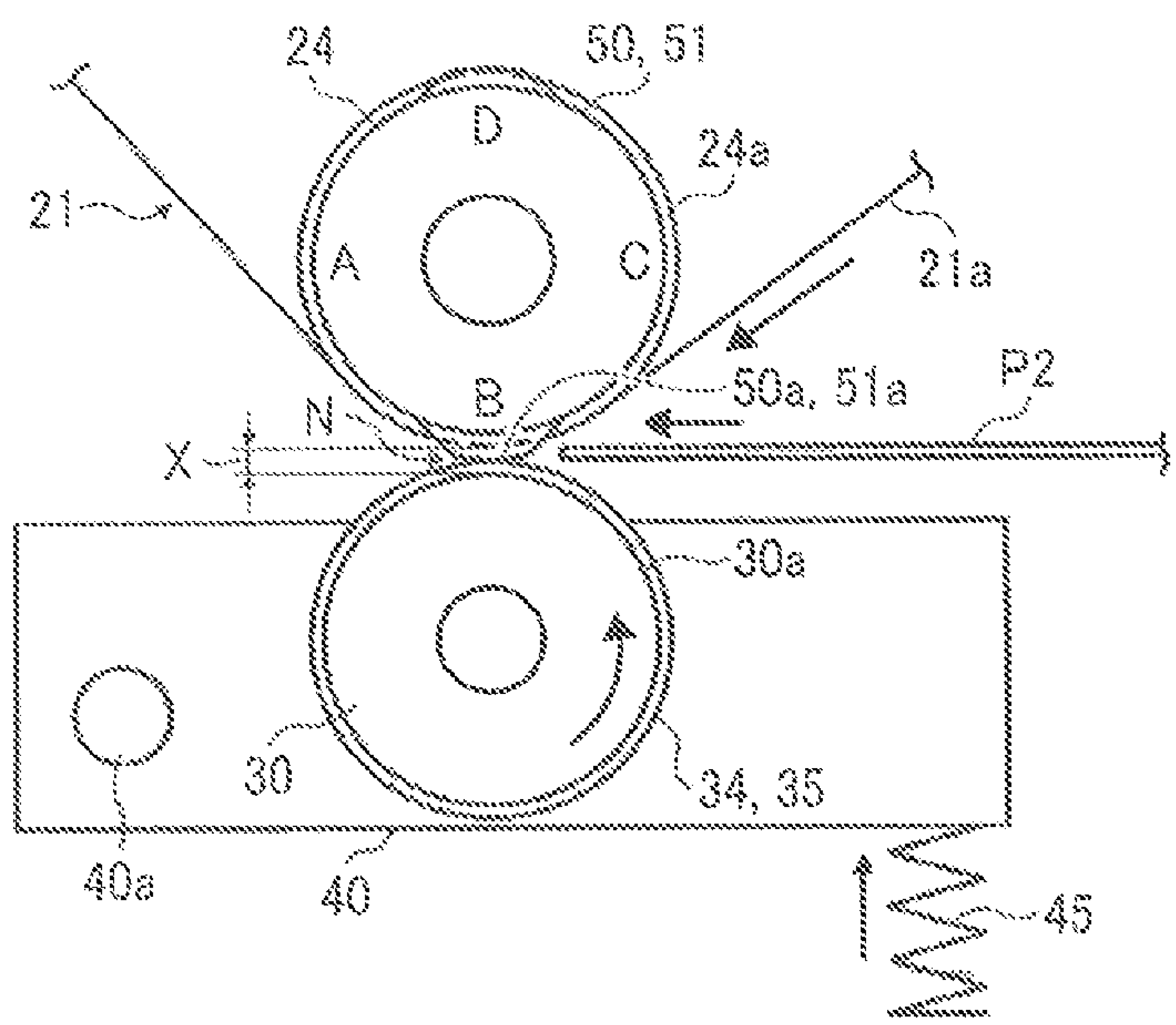

24
50, 51
D
24a
21
A
C
21a
B
50a, 51a
N
P2
X
30a
30
34, 35
40a
40
45

FIG. 8

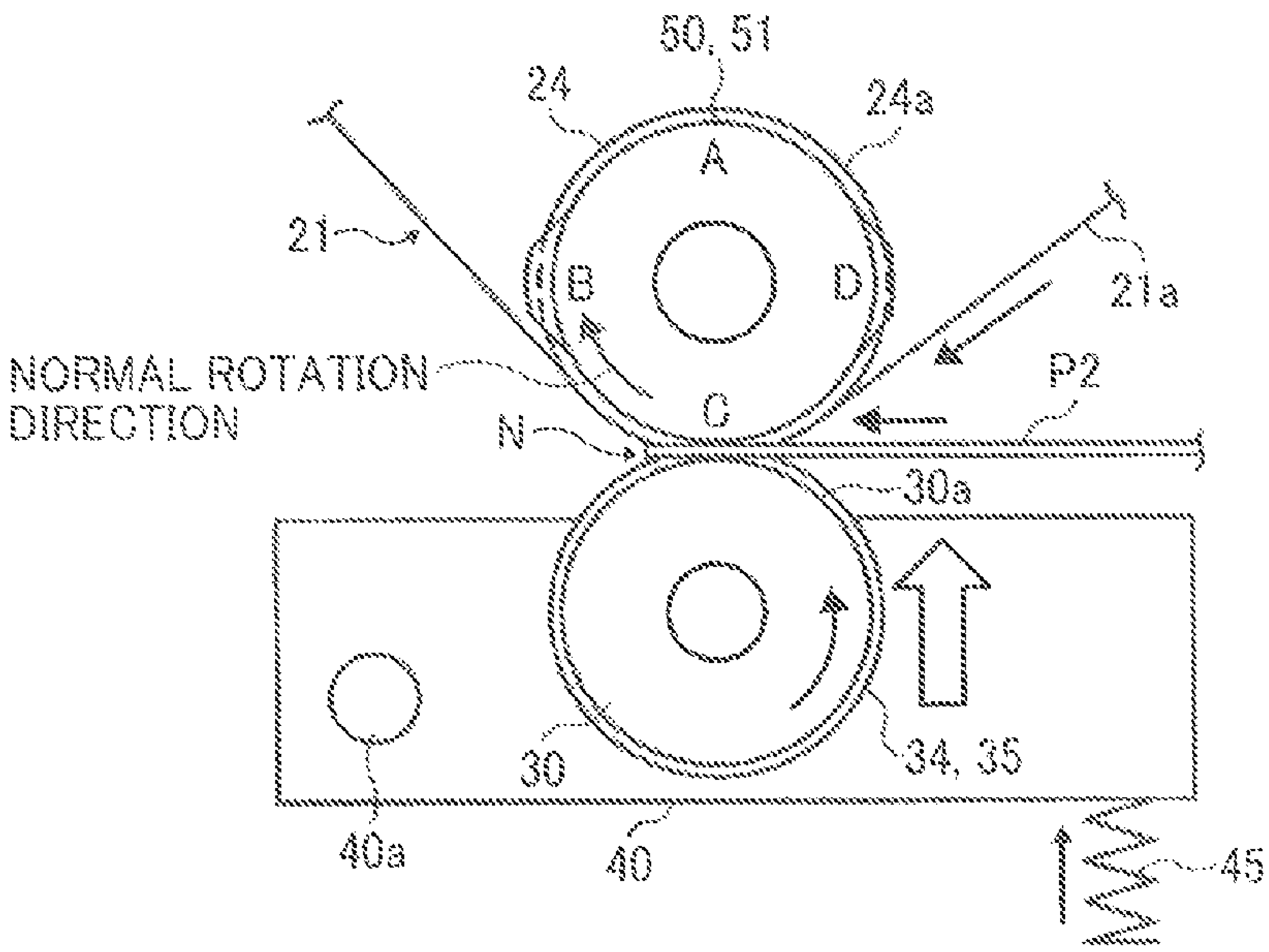

50, 51
24
24a
A
21
B
D
21a
NORMAL ROTATION DIRECTION
C
P2
N
30a
30
34, 35
40a
40
45

FIG. 9

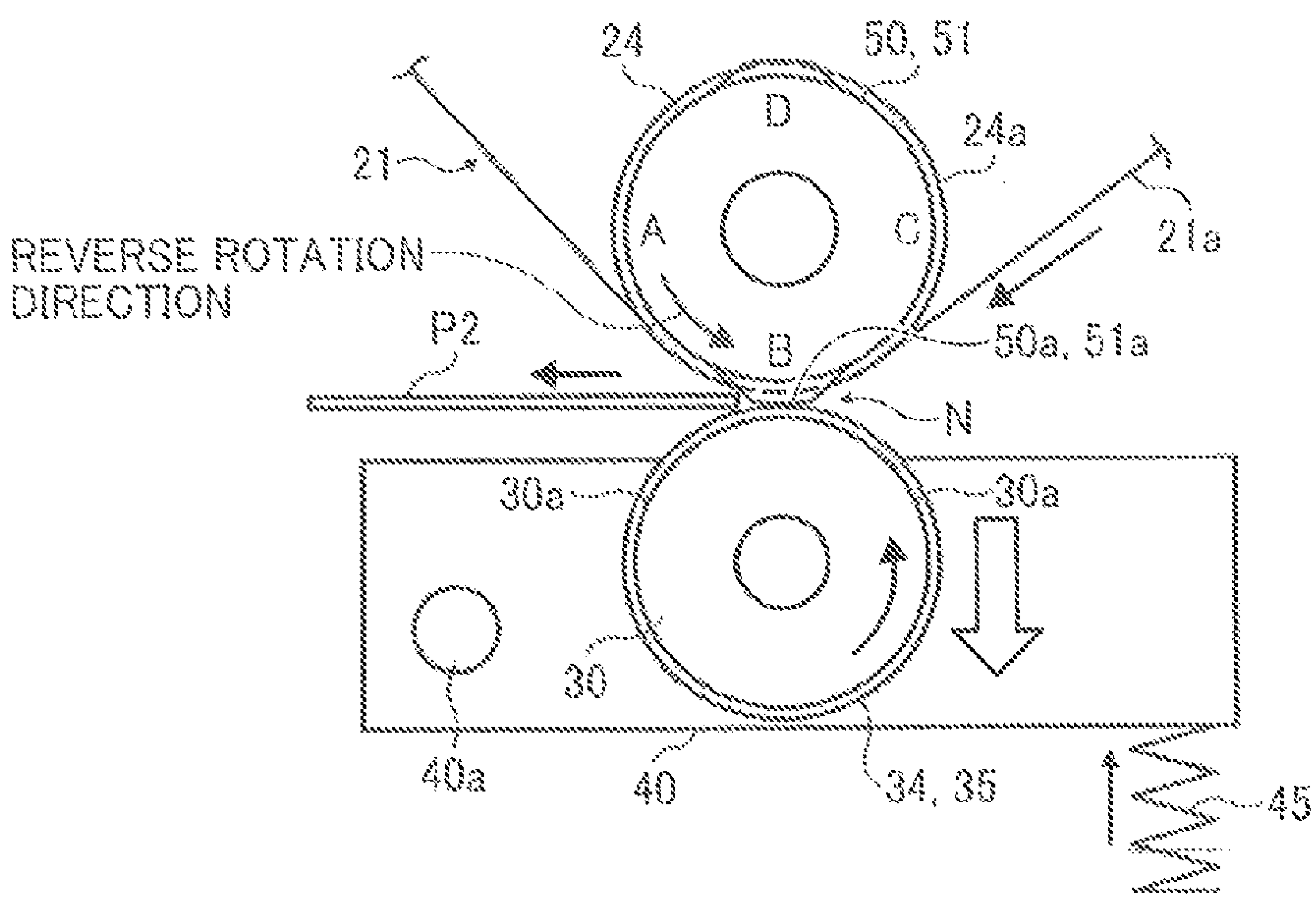

24
50, 51
D
24a
21
A
C
21a
REVERSE ROTATION DIRECTION
B
50a, 51a
P2
N
30a
30a
30
40a
40
34, 35
45

FIG. 10A

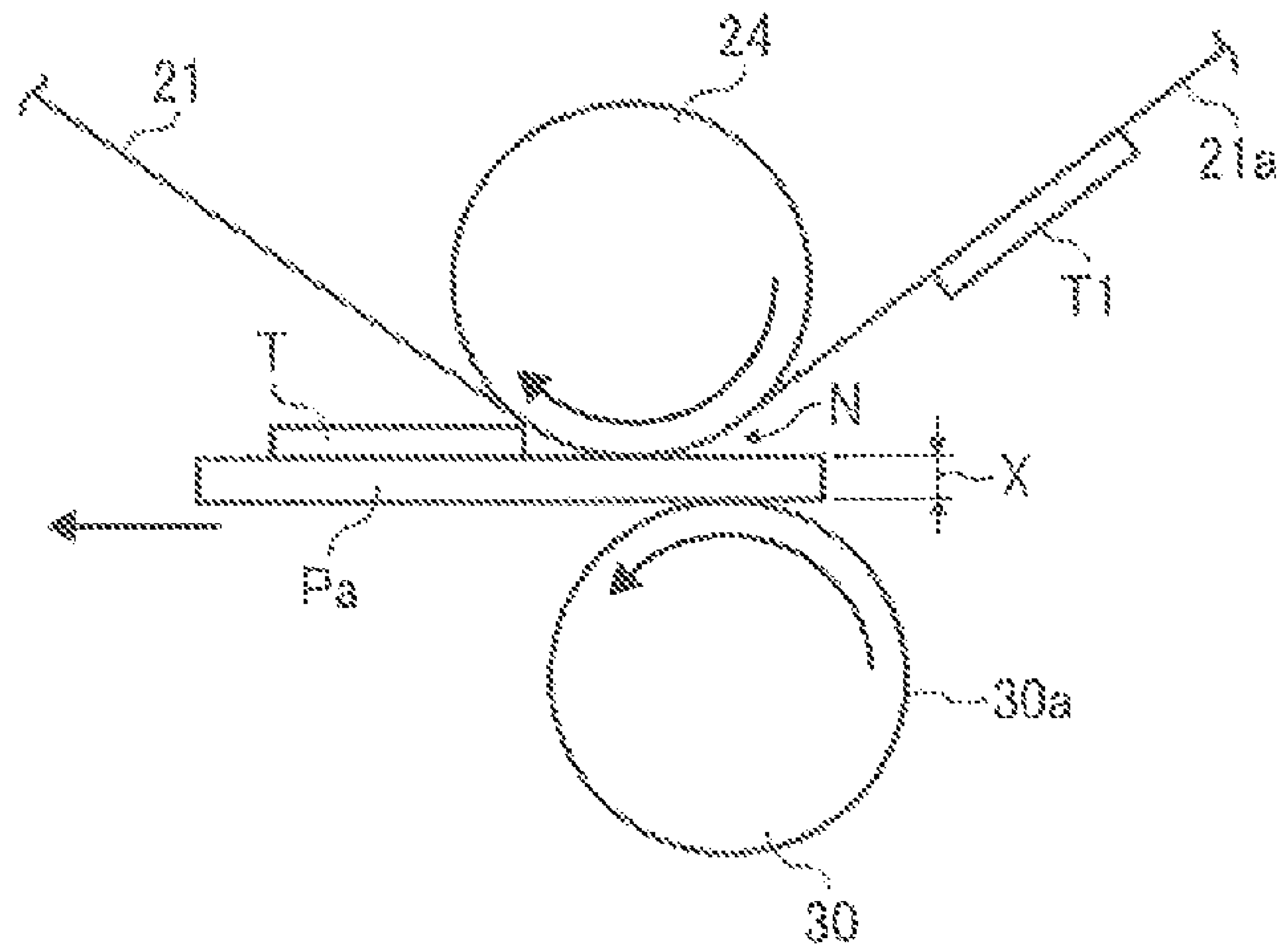


FIG. 10B

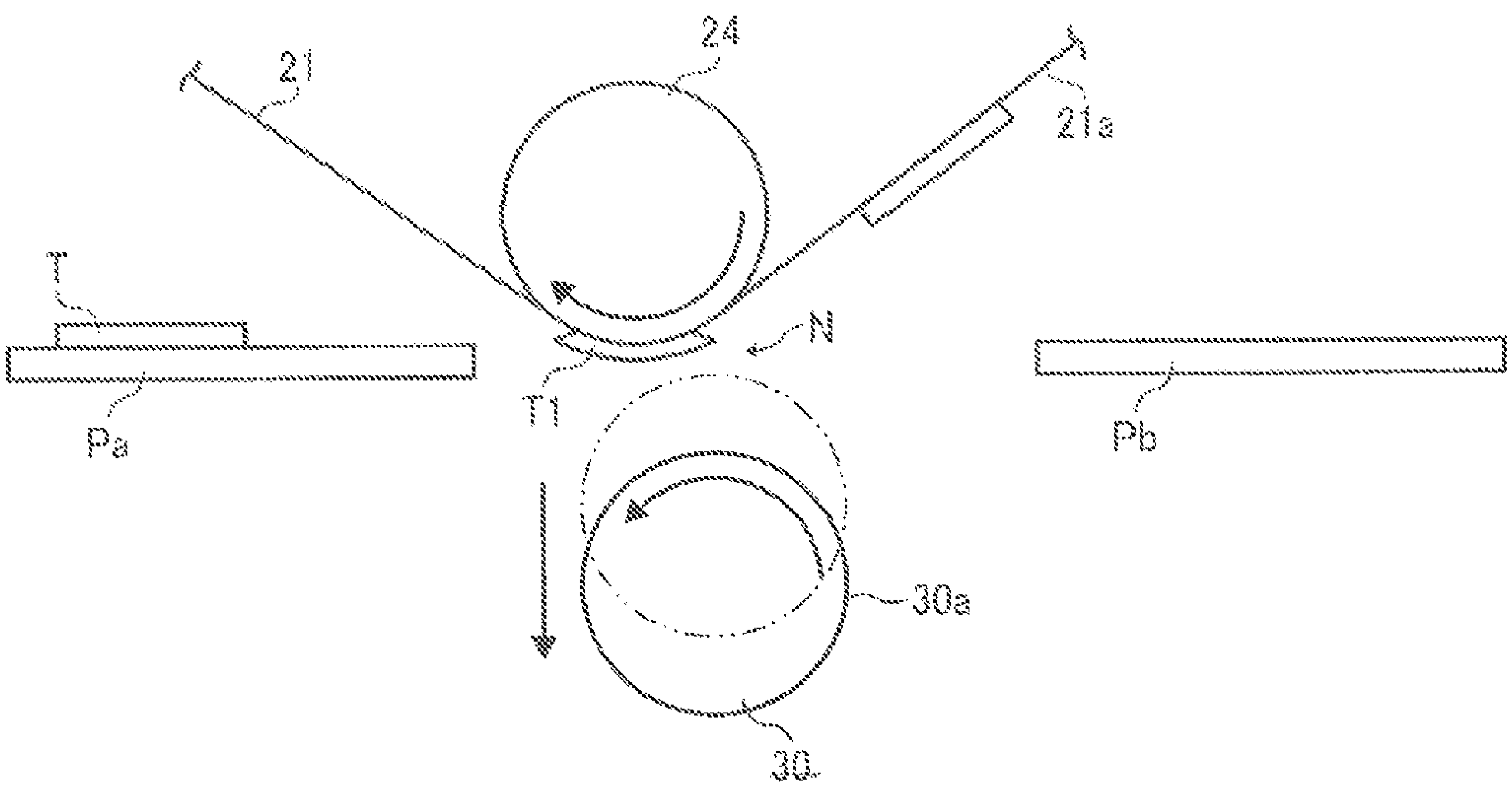


FIG. 11

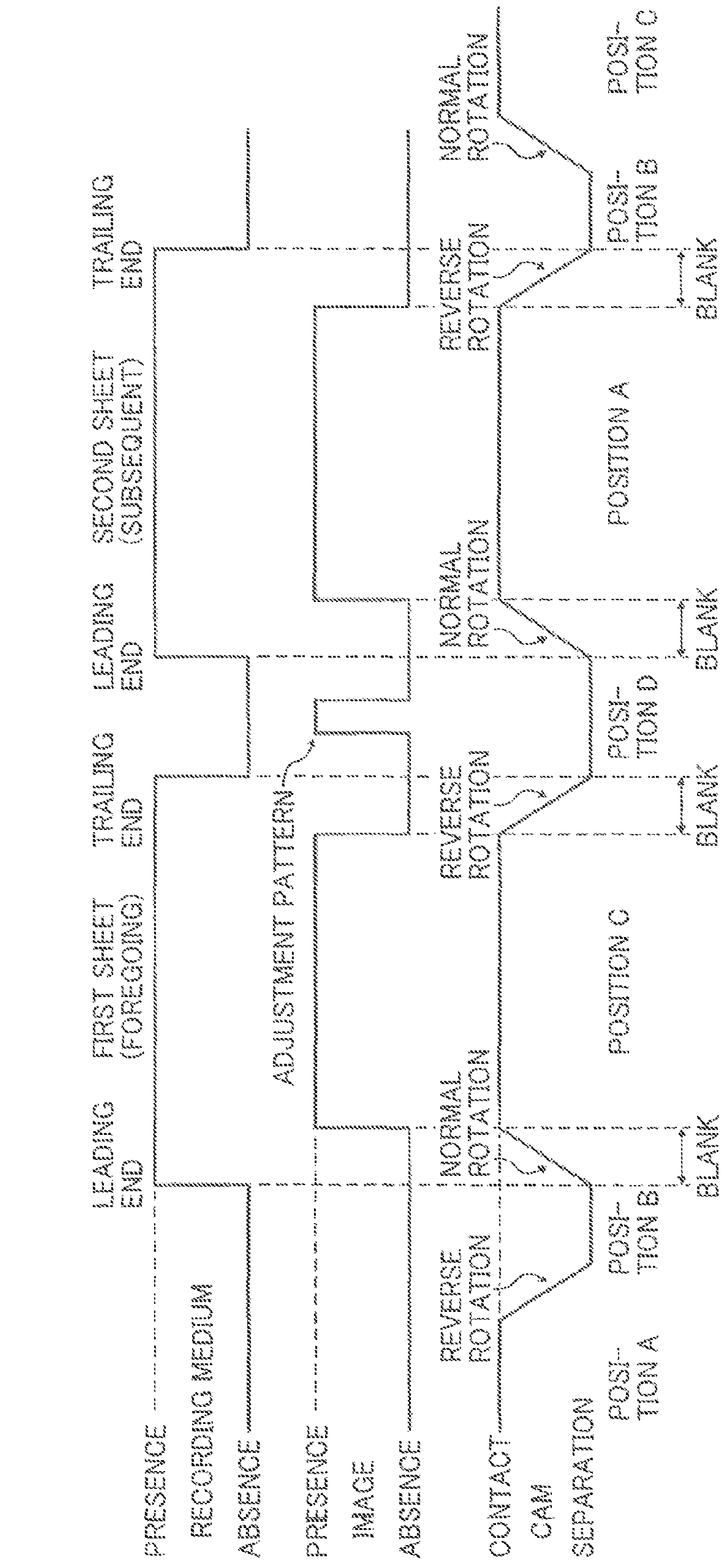

PRESENCE
RECORDING MEDIUM
ABSENCE
PRESENCE
IMAGE
ABSENCE
CONTACT
CAM
SEPARATION
POSI-TION A
REVERSE ROTATION
POSI-TION B
LEADING END
NORMAL ROTATION
BLANK
FIRST SHEET (FOREGOING)
ADJUSTMENT PATTERN
POSITION C
TRAILING END
REVERSE ROTATION
BLANK
POSI-TION D
LEADING END
NORMAL ROTATION
BLANK
SECOND SHEET (SUBSEQUENT)
POSITION A
TRAILING END
REVERSE ROTATION
BLANK
POSI-TION B
NORMAL ROTATION
POSI-TION C

FIG. 12

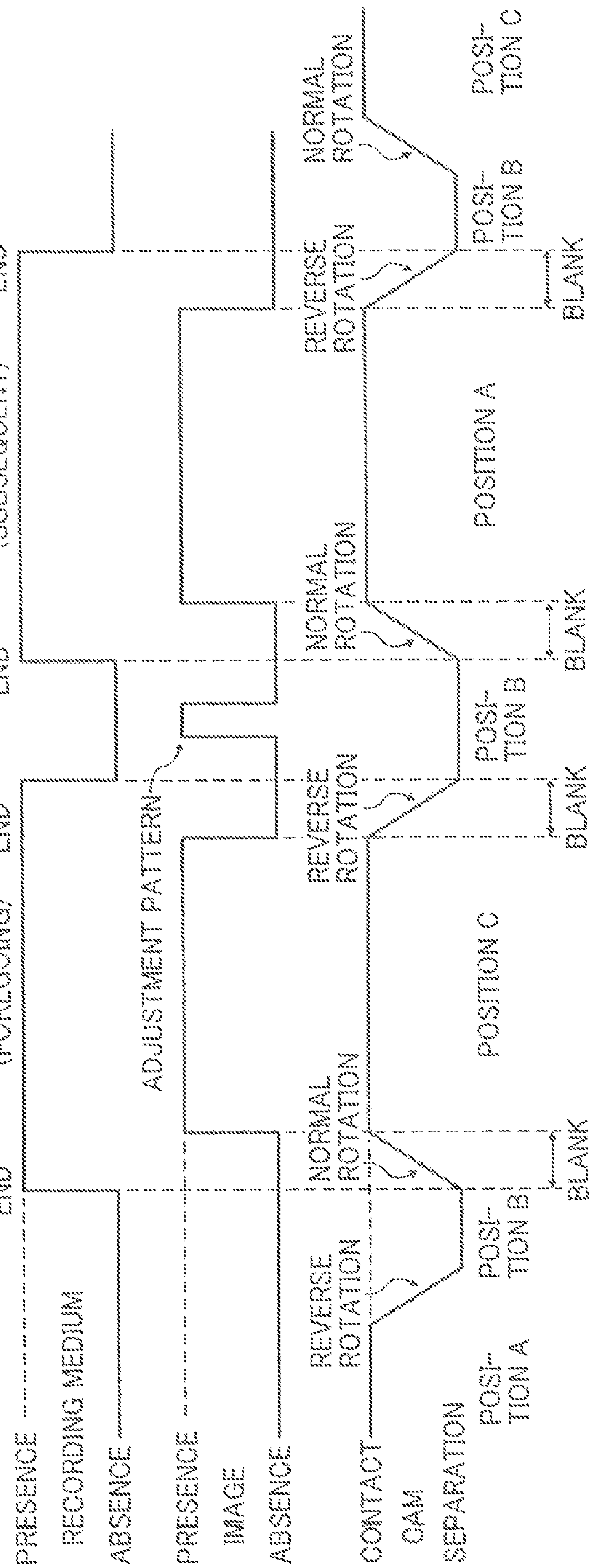

PRESENCE
RECORDING MEDIUM
ABSENCE
PRESENCE
IMAGE
ABSENCE
CONTACT
CAM
SEPARATION
LEADING END
FIRST SHEET (FOREGOING)
TRAILING END
LEADING END
SECOND SHEET (SUBSEQUENT)
TRAILING END
ADJUSTMENT PATTERN
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
POSI-TION A
POSI-TION B
POSITION C
POSI-TION B
POSITION A
POSI-TION B
POSI-TION C
BLANK
BLANK
BLANK
BLANK

FIG. 13

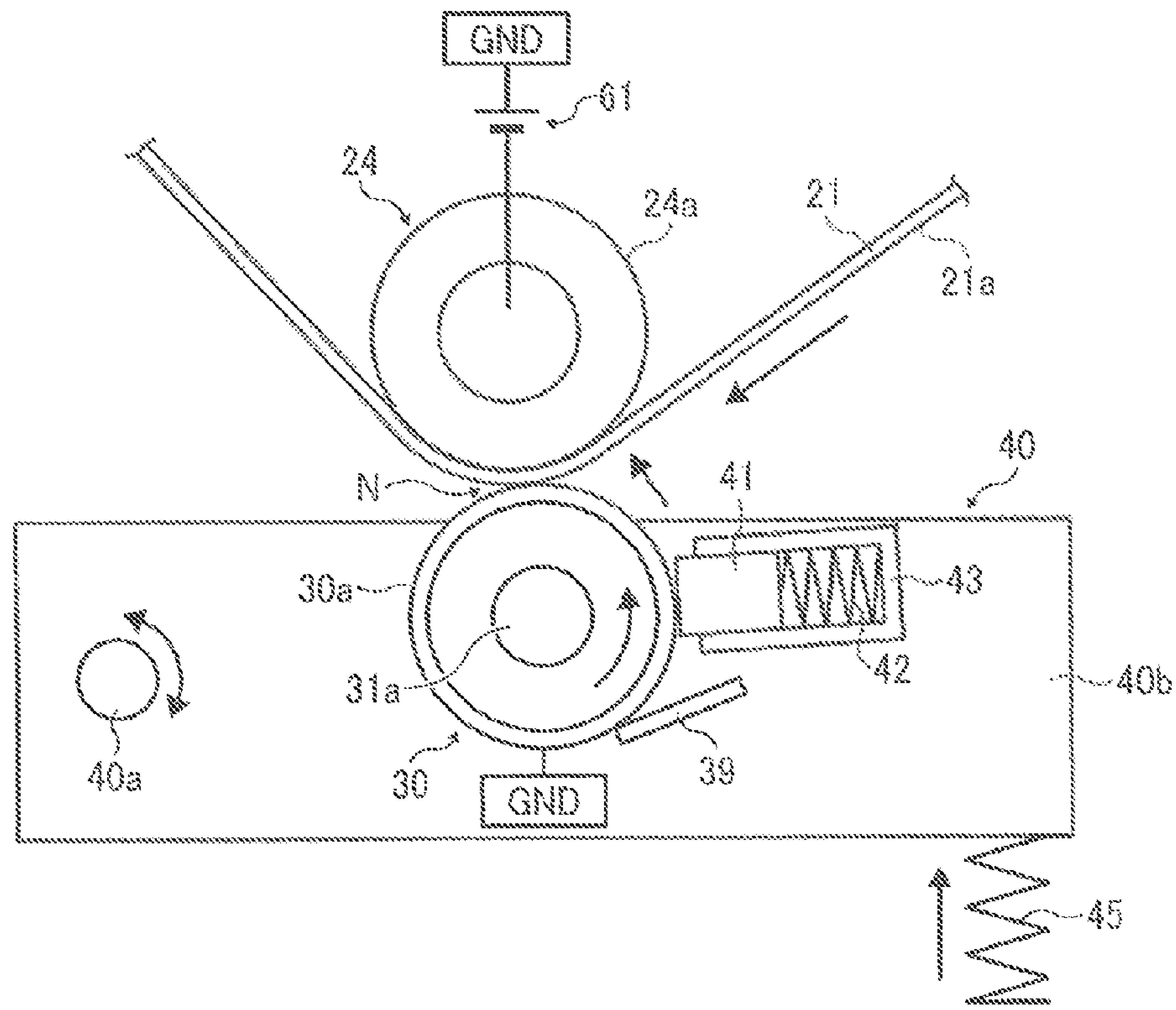

GND
61
24
24a
21
21a
40
N
41
30a
43
31a
42
40b
40a
30
GND
39
45

FIG. 14

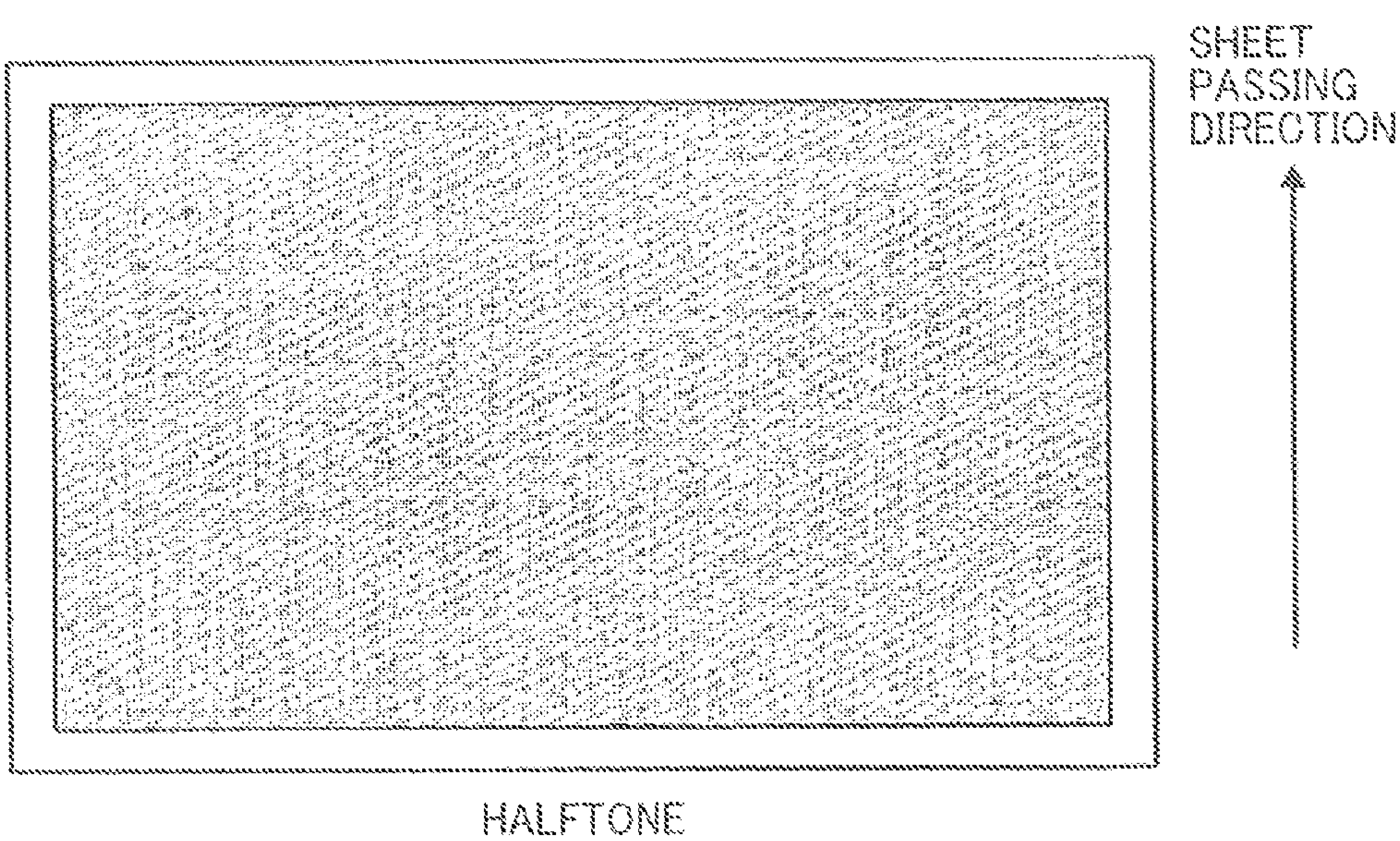
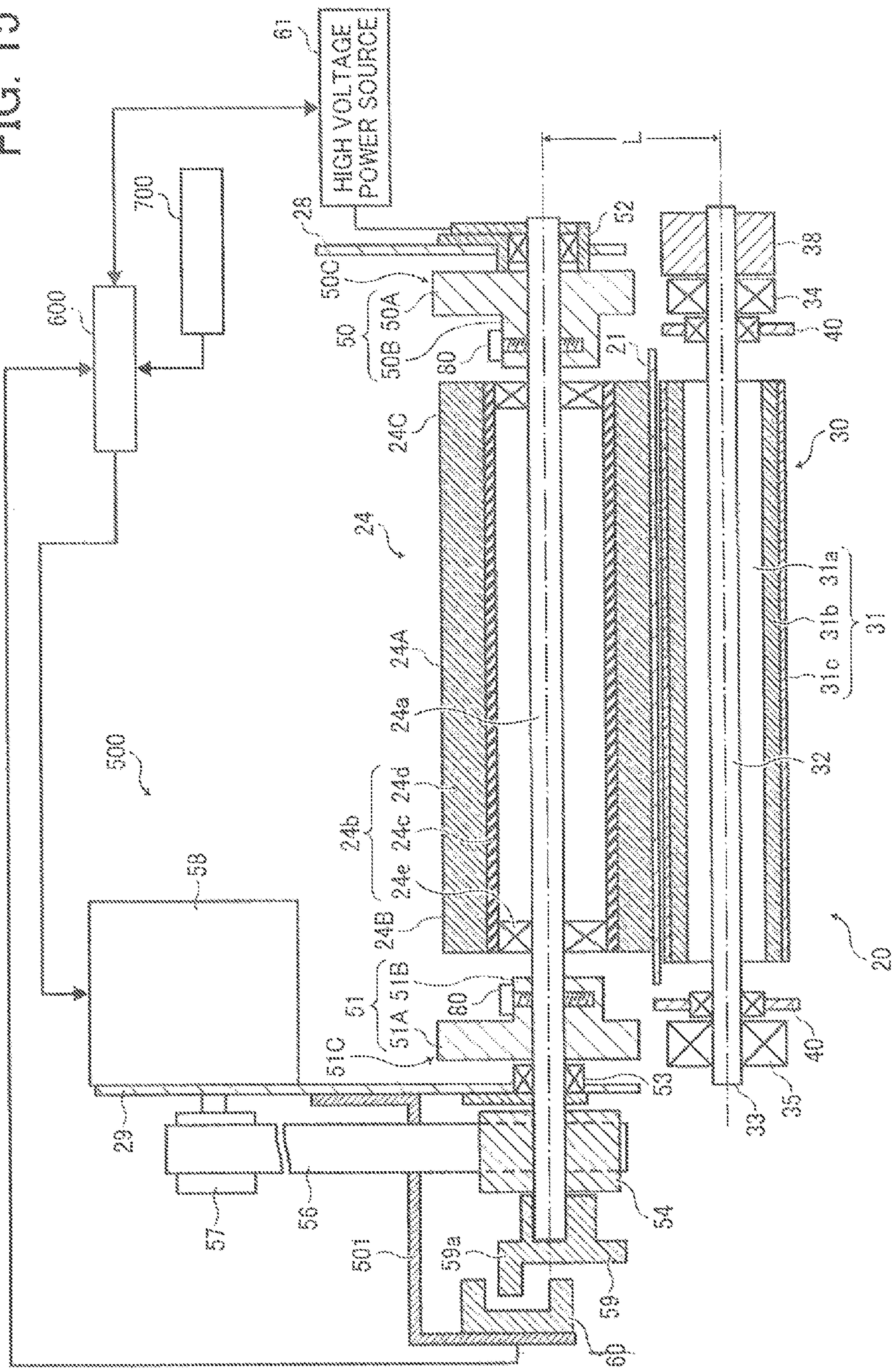

SHEET
PASSING
DIRECTION
HALFTONE

FIG. 15


HIGH VOLTAGE POWER SOURCE
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700
600
500
58
29
57
56
501
59a
59
60
54
53
51C
51A 51B
51
80
24B
24e 24c 24d
24b
24a
24A
24
24C
50B 50A
50
50C
28
52
21
38
34
40
30
31a 31b 31c
31
32
20
35
33
L

FIG. 16

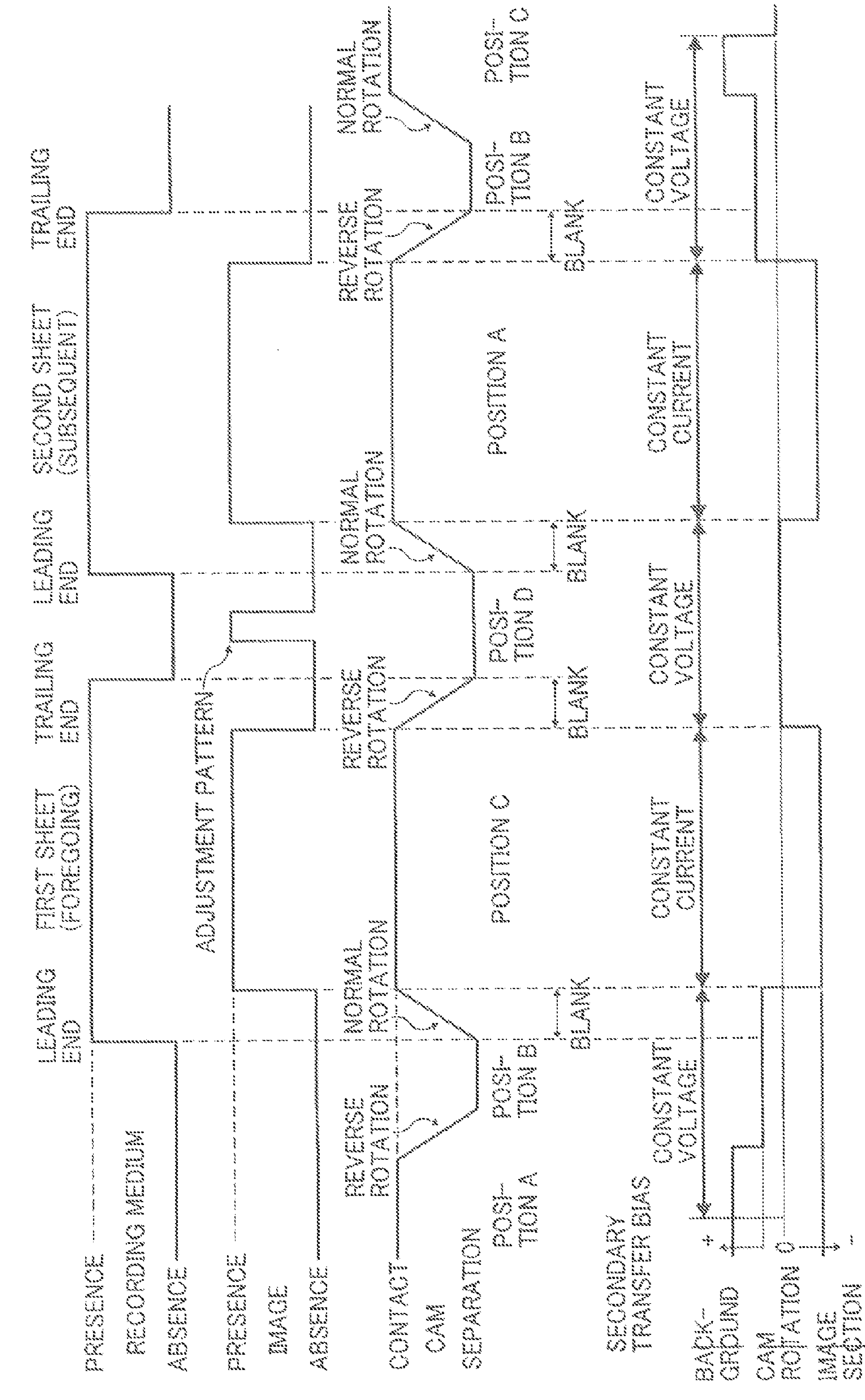
PRESENCE
RECORDING MEDIUM
ABSENCE
PRESENCE
IMAGE
ABSENCE
CONTACT
CAM
SEPARATION
SECONDARY TRANSFER BIAS
BACK-GROUND
CAM ROTATION
IMAGE SECTION
+
0
-
LEADING END
FIRST SHEET (FOREGOING)
TRAILING END
LEADING END
SECOND SHEET (SUBSEQUENT)
TRAILING END
ADJUSTMENT PATTERN
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
POSI-TION A
POSI-TION B
POSITION C
POSI-TION D
POSITION A
POSI-TION B
POSI-TION C
BLANK
BLANK
BLANK
BLANK
CONSTANT VOLTAGE
CONSTANT CURRENT
CONSTANT VOLTAGE
CONSTANT CURRENT
CONSTANT VOLTAGE

FIG. 17

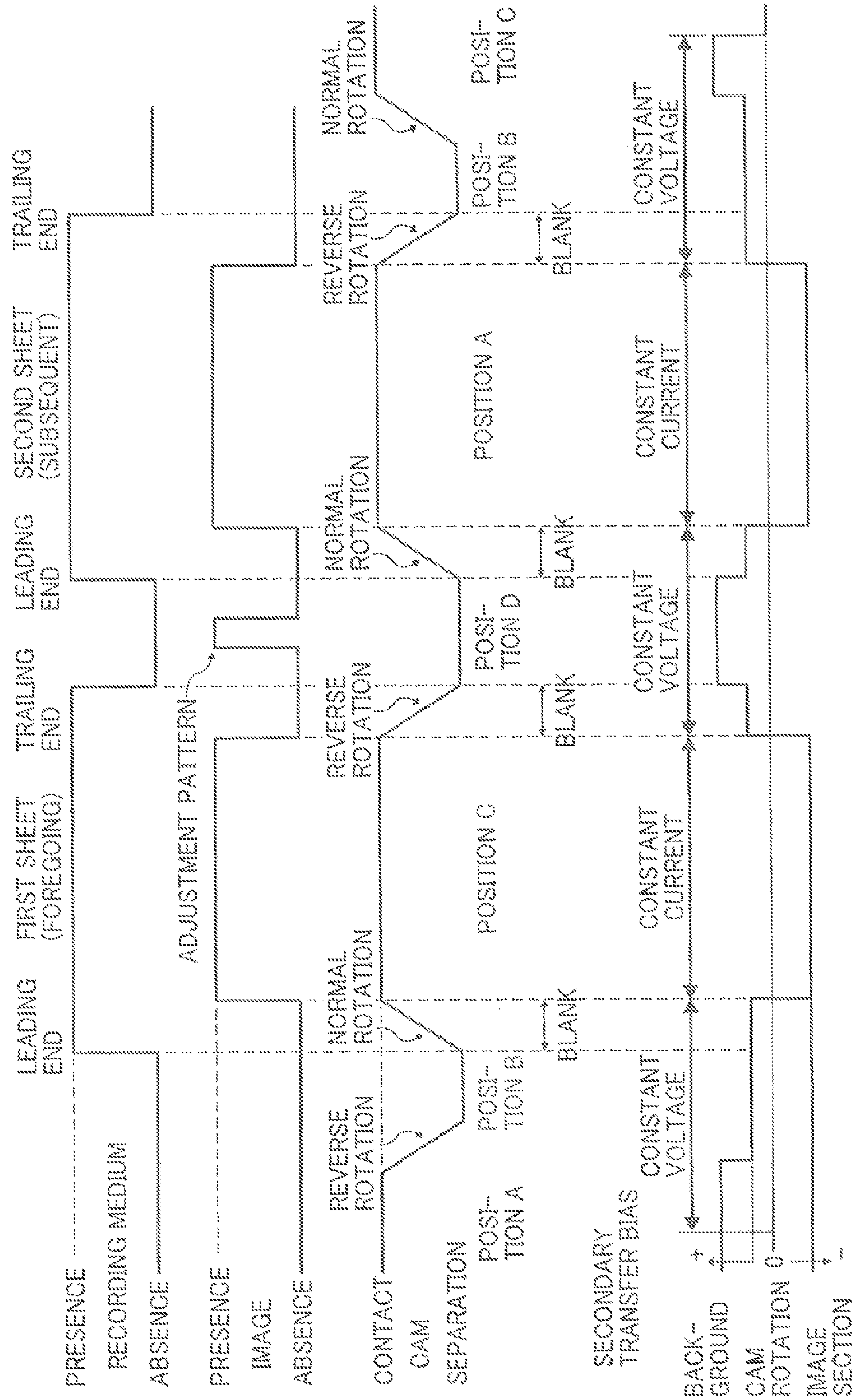
PRESENCE
RECORDING MEDIUM
ABSENCE
PRESENCE
IMAGE
ABSENCE
CONTACT
CAM
SEPARATION
SECONDARY TRANSFER BIAS
BACK-GROUND
CAM ROTATION
IMAGE SECTION
+
0
-
LEADING END
FIRST SHEET (FOREGOING)
TRAILING END
LEADING END
SECOND SHEET (SUBSEQUENT)
TRAILING END
ADJUSTMENT PATTERN
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
REVERSE ROTATION
NORMAL ROTATION
POSI-TION A
POSI-TION B
POSITION C
POSI-TION D
POSITION A
POSI-TION B
POSI-TION C
BLANK
BLANK
BLANK
BLANK
BLANK
CONSTANT VOLTAGE
CONSTANT CURRENT
CONSTANT VOLTAGE
CONSTANT CURRENT
CONSTANT VOLTAGE

FIG. 18

TABLE 1

	COLOR COPY 160g/m^2		COLOR COPY 320g/m^2	
	POOR IMAGE	BACKSIDE STEIN	POOR IMAGE	BACKSIDE STEIN
FIRST PRACTICAL EXAMPLE	○	○	△	○
SECOND PRACTICAL EXAMPLE	○	○	○	○
THIRD PRACTICAL EXAMPLE	○	○	○	○
FOURTH PRACTICAL EXAMPLE	○	○	○	○
FIRST COMPARATIVE EXAMPLE	×	○	×	○
SECOND COMPARATIVE EXAMPLE	×	×	×	×
THIRD COMPARATIVE EXAMPLE	×	×	×	×

TRANSFER DEVICE AND IMAGE FORMING APPARATUS INCORPORATING TRANSFER DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority pursuant to 35 USC §119 to Japanese Patent Application Nos. 2010-133058 and 2010-194913 filed on Jun. 10 and Aug. 31 both 2010, respectively, the entire contents of which are hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a transfer device and an image forming apparatus having the transfer device that transfers an image onto a recording medium at a transfer nip formed between an image bearer and a transfer member contacting the image bearer.

2. Description of the Background Art

In an image forming apparatus which employs an engaging and disengaging mechanism capable of engaging and disengaging an opposed member from an image bearer to create a transfer nip therebetween under a prescribed bias applied from a biasing device, a linear density unevenness called an impact jitter is sometimes induced when a cardboard is used as the recording medium. Because, a load on the image bearer sharply increases and a line speed thereof largely decreases when the cardboard enters the transfer nip.

The Japanese Patent Application Laid Open No. 10-83124 (JP-10-83124-A) typically suppresses the impact jitter with a transfer roller that includes a cylindrical column roller section and shafts integrally and rotatavely protruding from both side ends thereof and rotation cams capable of providing idling rotation around the shafts. The rotation cam includes a convex at a prescribed rotation angular position to collide with one end of a photoconductive member serving as the image bearer in the shaft direction. Such collision forcibly moves the transfer roller apart from the photoconductive member against a bias force applied by a pressing device toward the photoconductive member, so that a shaft distance between the photoconductive member and the transfer roller is adjusted. When the cardboard is used as a recording medium, the shaft distance is broadened and a transfer pressure is decreased or the transfer roller is disengaged therefrom. As a result, the load on the photoconductive member, which is necessarily generated when the cardboard enters, is suppressed.

Although the sharp increase in load can be avoided by broadening the shaft distance as shown in the JP-H10-83124-A, a transfer error is likely induced due to shortage of transfer pressure. To resolve such a problem, the Japanese Patent Application Laid Open No. 06-274051 (JP-H06-274051-A) provides an image forming apparatus in that a transfer roller is disengaged from a photoconductive member by driving a rotation cam and form a small gap between the transfer roller and the photoconductive member prior to entrance of a cardboard as a recording medium into a transfer nip to suppress impact jitter. Subsequently, by stopping an operation of a solenoid after entrance of a tip of the cardboard into the above-described small gap and releasing the forcible movement of the transfer roller, and thereby subjecting the transfer roller to a biasing force of a spring that serves as a pressing device to press the transfer roller against the photoconductive member, the transfer error is suppressed by applying a sufficient transfer pressure to a recording medium during a transfer process.

It is typically known that an adjustment pattern is timely formed at a prescribed position not to be transferred onto a recording medium under a prescribed image formation condition, such as when an image formation performance is checked to stabilize image quality in an image forming apparatus that includes a transfer device that superimposes images formed on multiple image bearers onto an intermediate transfer member and transfers those at once using an opposed member opposed to the intermediate transfer member.

For example, the Japanese Patent Application Laid Open No. 2007-286176 proposes a system that forms an adjustment pattern on a portion corresponding to an interval between sheets and separates and opens a secondary transfer nip in that case.

Further, the Japanese Patent Application Laid Open No. 2009-145778 proposes a system that disengages an opposed member from an intermediate transfer member when an adjustment pattern passes through a secondary transfer nip and opens a shutter of a detection sensor so that separation of the opposed member and opening and closing of the shutter of the detection sensor are synchronized with each other. Yet further, the Japanese Patent Application Laid Open No. 2006-047779 describes a technique in that a voltage having the same polarity as toner is applied to a secondary transfer nip where an intermediate transfer member contacts a secondary transfer member and an adjustment pattern passes therethrough not to transfer the adjustment pattern onto the secondary transfer member. Such a polarity is generally opposite to that applied to execute transferring onto the intermediate transfer member.

However, the above-described conventional techniques cannot obtain a fine image.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a novel image transfer system that comprises an image bearer and an opposed member having a contact surface contacting a recording medium and opposed to a surface of the image bearer to form a transfer nip therebetween. A pressing device is provided to apply pressure to the transfer nip. An engaging and disengaging member is provided to engage and disengage the contact surface from the surface of the image bearer. A transfer bias device is provided to apply an image transfer bias transferring an image formed on the image bearer onto the recording medium conveyed and pinched at the transfer nip. An adjustment pattern is formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip. The engaging and disengaging device disengages the contact surface from the surface of the image bearer to form a gap therebetween when the adjustment pattern passes therethrough. The transfer bias device applies a different bias than the image transfer bias when the adjustment pattern passes the gap.

In another aspect, the engaging and disengaging device includes a cam having at least two different cam portions changing a size of the gap when rotated, a cam driving device that rotates and stops the cam, and a cam controller that controls the cam driving device. The cam controller controls the cam driving device to rotate and stop the cam at a first angular position minimizing the gap when the adjustment pattern passes therethrough.

In yet another aspect, a bias controller instructs the transfer bias device to stop applying the transfer bias when the gap is formed.

In yet another aspect, the bias controller instructs the transfer bias device to apply a bias having a prescribed polarity to the transfer nip when the adjustment pattern passes therethrough. The polarity is opposite to that of an image transfer bias applied when an image is transferred onto the recording medium.

In yet another aspect, an absolute value of said opposite bias is smaller than that of the image transfer bias.

In yet another aspect, the gap is broadened repelling the opposed member against the pressure by rotating and stopping the cam at a second rotation angular position before exit of a trailing end of a former recording medium passing through the transfer nip therefrom.

In yet another aspect, the gap is narrowed by rotating and stopping the cam at a third rotation angular position before entrance of a leading end of the subsequent recording medium into the transfer nip.

In yet another aspect, the transfer bias is turned on and off synchronizing with the rotation of the cam.

In yet another aspect, the engaging and disengaging device includes a cam having at least two different cam portions changing a size of the gap when rotated, a cam driving device to rotate and stop the cam, and a cam controller to control the cam driving device. The cam controller controls the cam driving device to rotate and stop the cam at a prescribed angular position changing the gap in accordance with a thickness of the recording medium.

BRIEF DESCRIPTION OF DRAWINGS

A complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a chart illustrating the entire configuration of an exemplary image forming apparatus according to one embodiment of the present invention;

FIG. **2** is an enlarged view illustrating an exemplary secondary transfer nip and surroundings of a transfer device according to one embodiment of the present invention;

FIG. **3** is an enlarged cross sectional view illustrating the surroundings of the exemplary secondary transfer nip;

FIG. **4** is an enlarged view illustrating an exemplary shape of an outer diameter of a cam disposed in a secondary transfer opposed roller;

FIG. **5** is an exemplary profile showing a change in diameter of a cam;

FIG. **6** is an enlarged view illustrating an exemplary condition of the secondary transfer nip right before a recording medium enters thereto in the transfer device;

FIG. **7** is an enlarged view illustrating an exemplary condition of the secondary transfer nip right before a cardboard enters thereto in the transfer device;

FIG. **8** is an enlarged view illustrating an exemplary condition of the secondary transfer nip right after the cardboard enters thereto in the transfer device;

FIG. **9** is an enlarged view illustrating an exemplary condition of the secondary transfer nip right after the cardboard exits thereof in the transfer device;

FIG. **10**A illustrates an exemplary condition of the secondary transfer nip when an image formed on an intermediate transfer member is transferred onto a previous recording medium;

FIG. **10**B illustrates an exemplary condition of the secondary transfer nip when a leading end of the next recording medium enters thereto after an adjustment pattern passes therethrough;

FIG. **11** is a time chart illustrating an exemplary sequence of a sheet, an adjustment pattern, and a position of a cam according to a first embodiment of the present invention;

FIG. **12** is a time chart illustrating an exemplary sequence of a sheet, an adjustment pattern, and a position of a cam according to a second embodiment of the present invention;

FIG. **13** is an enlarged view illustrating another exemplary secondary transfer nip and surroundings of a transfer device;

FIG. **14** illustrates an exemplary image pattern;

FIG. **15** is an enlarged view illustrating an exemplary secondary transfer nip and surroundings of a transfer device according to third and fourth embodiments of the present invention;

FIG. **16** is a time chart illustrating an exemplary sequence of a sheet, an adjustment pattern, a position of a cam, and a secondary transfer bias according to a third embodiment of the present invention;

FIG. **17** is a time chart illustrating an exemplary sequence of a sheet, an adjustment pattern, a position of a cam, and a secondary transfer bias according to a fourth embodiment of the present invention; and

FIG. **18** illustrates an experimental result showing sheet passage performances obtained under various conditions.

PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout several views, in particular in FIG. **1**, an exemplary tandem type color image forming apparatus (hereinafter simply referred to as a copier) is described. The copier includes a printing section **10**, a sheet feeding section **200**, a scanner section **300** attached above the printing section **100**, and an automatic document feeder **400** attached above the scanner section **300**. Initially, a configuration and an operation of the entire copier are described, and specific features of this embodiment are then described.

The printing section **100** includes an endless belt type intermediate transfer belt **21** that serves as both an image bearer and an intermediate transfer member. The intermediate transfer belt **21** has a reverse triangle shape when viewed from its side and wound around a driving roller **22** as a rotation member, a driven roller **23**, and a secondary transfer opposed roller **24** serving as a supporting member, and is moved clockwise in the drawing by a rotation and driving of the driving roller **22**.

The image formation units **1**C to **1**K include drum state photoconductive members **2**C to **2**K serving as image bearers, developing units **3**C to **3**K, and cleaning devices **4**C to **4**K for photoconductive member use, respectively. The photoconductive members **2**C to **2**K contact the intermediate transfer belt **21** and are driven and rotated by a driving device, not shown, while creating primary transfer nips for C to K use. The developing units **3**C to **3**K develop latent images formed on the photoconductive members **2**C to **2**K with C to K color toner, respectively. The cleaning devices **4**C to **4**K clean the photoconductive members **2**C to **2**K passing through the primary transfer nip by removing toner remaining and attracted thereto after transferring. An image formation section **10** is formed in a tandem state in this printer by disposing those side by side in a belt moving direction.

Above the tandem image formation section **10**, there is provided an optical writing unit **15** in this printing section **100** to provide an optical writing process to surfaces serving as image bearing surfaces of the photoconductive members **2**C to **2**K driven and rotated counter clockwise in the drawing to form latent images thereon. Prior to this optical writing process, each of the surfaces of the photoconductive members is uniformly charged by a charger, not shown, provided in each of the image formation units **1**C to **1**K.

The transfer unit **20** serves as a transfer device and includes an intermediate transfer belt **21** and primary rollers **25**C to **25**K pressing the intermediate transfer belt **21** toward the photoconductive members **2**C to **2**K from an inside of the loop thereof.

Below the intermediate transfer belt **21**, there is provided a secondary transfer roller **30** opposed to a surface **21***a* as an image bearing surface of the intermediate transfer belt **21** to serve as an opposed member and support the intermediate transfer belt **21** from an inside thereof. The secondary transfer roller **30** contacts, via the intermediate transfer belt **21**, a winding section of the transfer opposed roller **24** from the surface **21***a* of the belt and creates a secondary transfer nip N thereon. A recording medium P is conveyed into the secondary transfer nip N at a prescribed time. Toner images of respective four colors are superimposed and transferred onto the belt surface **21***a* at the primary transfer nips, and thus superimposed toner images are then secondary transferred onto the recording medium P at once at the secondary transfer nip N.

The scanner section **300** reads image information on an original document placed on a platen glass **301** with a reading sensor **302** and transmits the image information to a control section of the printing section **100**. The controller section **600** controls a laser diode and a light source, such as a LED, etc., provided in the optical writing unit **15** of the scanner section **100** to emit a laser writing light of C to K colors to each of the respective photoconductive members **2**C to **2**K as an optical scanning process in accordance with the image information. With the optical scanning process, latent images are formed on the surfaces of the respective photoconductive members and are developed as toner images of C to K colors during prescribed developing processes.

The sheet feeding section **200** includes a sheet feed cassette **202** provided in multiple steps in a paper bank **201**, a sheet feeding roller **203** that launches a recording medium P from the sheet feed cassette **202**, a separation roller **205** that separates the recording mediums P launched thereto and guides those to a sheet path **204**, and a conveyance roller **206** that conveys the recording medium P to a sheet path **99** provided in the printing section **100**.

A manual recording medium tray **98** is provided to manually feed sheets. A separation roller **98** is also provided to manually feed sheets on the manual recording medium tray **98** to a manual sheet feeding path **97** one by one beside sheet feeding from the sheet feeding section **200**. The manual sheet feeding path **97** flows together with the sheet feeding path **99** in the printing section **100**.

A pair of registration rollers **95** is provided as a recording medium supply device in the vicinity of the end of the sheet feeding path **99**. The pair of registration rollers **95** pinches the recording medium P coming in the sheet feeding path **99** and launches it to a secondary transfer nip N at a prescribed time.

To make a copy of a color image in the copier of this embodiment, an original document is placed onto an original document table **401** provided on the automatic document feeder. Otherwise, the automatic document feeder **400** is open and an original document is placed on a platen glass **301** provided in the scanner section **300**. The automatic document feeder **400** is then closed to press the original document. When the original document is placed on the automatic document feeder **400** and a start switch, not shown, is depressed, the original document is conveyed onto the platen glass **301**. Subsequently, as the scanner section **300** starts driving, first and second carriages **303** and **304** start running along the surface of the original document. Then, a light emitted from the light source in the first carriage **303** is reflected by the surface of the original document and is further reflected and directed toward the second carriage **304**. The reflected light enters a reading sensor **302** passing through an imaging lens **305** after a mirror in the second carriage reflects thereof. Hence, the original document is read.

Upon receiving the image information from the scanner section **300**, a recording medium P having a size corresponding to the image information is fed to the sheet feeding path **99** in the printing section **100**. Simultaneously, a motor, not shown, drives and rotates the driving roller **22** and moves the intermediate transfer belt **21** counter clockwise in the drawing. At the same time, after start driving and rotating the photoconductive members **2**C to **2**K in the image formation units **1**C to **1**K, uniform charging, optical writing, and developing processes are executed thereto. Thus, the toner images of C to K colors on the respective surfaces of the photoconductive member are superimposed one after another at the primary transfer nips for C to K uses and are primarily transferred onto the intermediate transfer belt **21**, so that a four color-superimposed toner image is obtained.

In the sheet feeding section **200**, one of sheet feeding rollers **203** is selectively rotated in accordance with a size of the recording medium, and thus the recording mediums P are launched from one of three sheet feed cassettes **202**. The recording medium P launched is separated one by one by the separation roller **205**, and is further launched into the sheet feeding path **206**. The recording medium is then conveyed into a sheet feeding path **99** in the printing section **100** via the conveyance roller **206**. When the recording medium **98** is used, a sheet feeding roller on the tray is driven and rotated, so that the recording medium on the tray is separated by the separation roller **96** and conveyed into the manual sheet feeding path **97** to reach the vicinity of the end of the sheet feeding path **99**. The recording medium P collides with and stops at a pair of registration rollers **95** in the vicinity of the end of the sheet feeding path **99**. Subsequently, as the pair of registration rollers **95** rotate at a time capable of synchronizing with the four color superimposed toner images on the intermediate transfer belt **21**, the recording medium P is conveyed into a secondary transfer nip N to tightly contact the four color superimposed toner images. Then, under influences of transfer pressure and a secondary transfer bias serving as a transfer electric field or the like, the four color superimposed toner images are secondarily transferred onto the recording medium P.

The recording medium P with the four color superimposed toner images is then conveyed into a fixing device **71** disposed in the printing section **100** by the belt **70**, and is pinched in a fixing nip formed therein between a pressing roller **72** and a fixing belt **73**. Subsequently, the four color superimposed toner images are fixed onto the surface by pressure and heat. The recording medium P with such a color image formed and fixed in this way is then stacked on a sheet ejection tray **75** disposed outside of the apparatus via a pair of sheet ejection rollers **74**.

When an image is also formed on the other surface (i.e., a rear side surface) of the recording medium P, it is conveyed to a recording medium reversing device **75** after being ejected from the fixing device **71** and a switching pick changes a course. Subsequently, when the recording medium P is reversed upside-down, it is returned again to the pair of registration rollers **95**, and is passes through the secondary transfer nip N and the fixing device **71** to fix the image. The recording medium P is then stacked on the sheet ejection tray **75**.

The cleaning device **26** contacts a belt surface **21***a* of the intermediate transfer belt **21** downstream of the secondary transfer nip N and upstream of the primary transfer nip for C color where an up most primary transfer process is executed among those of processes for four colors to clean thereof by removing toner attracted thereto and remaining thereon after such a transfer process.

An exemplary secondary transfer nip N and surroundings of the transfer unit disposed in the printing section **100** of the copier according to this embodiment is described with reference to FIG. **2**. As shown, the secondary transfer opposed roller **24** is disposed inside a loop and is thereby partially wound around by the flexible intermediate transfer belt **21** to support and back it up with its circumference to maintain a shape thereof tracing a prescribed curvature thereof. Accordingly, the secondary transfer opposed roller **24** functions as a backup roller. The secondary transfer roller **30** contacts a belt front surface **21***a* of a winding portion on the intermediate transfer belt **21** winding the secondary transfer opposed roller **24** to form a secondary transfer nip N thereon.

The secondary transfer roller **30** is freely rotatably held on a roller unit holder **40** via a bearing, not shown. The roller unit holder **40** is swingable around a rotation shaft **40***a* to take a posture in parallel to a rotation axis of the secondary transfer roller **30**. When the roller unit holder **40** rotates counter clockwise in the drawing around the rotation axis **40***a*, a secondary transfer roller **30** held on the roller unit holder **40** is pressed against the intermediate transfer belt **21** and forms a secondary transfer nip N thereon. Whereas when the roller unit holder **40** rotates clockwise in the drawing around the rotation axis **40***a*, the secondary transfer roller **30** held by the roller unit holder **40** disengages from the intermediate transfer belt **21**. In the transfer unit **20**, an end **40***b* of the roller unit holder **40** on the opposite side of the rotation shaft **40***a* is always biased toward the intermediate transfer belt **21** by a biasing coil spring **45** as a biasing device. By always applying a force using the biasing coil spring **45** to the roller unit holder **40** to rotate it counter clockwise in the drawing around the rotation axis **40***a*, the secondary transfer roller **30** is biased toward the intermediate transfer belt **21**.

When a rotation driving force is transmitted from the roller driving motor via a driving transmission device, such as a gear, etc., not shown, the secondary transfer roller **30** is driven and rotated counter clockwise in the drawing. These roller driving motor and driving transmission device are held by the roller unit holder **40** and enabled to rotate together with the secondary transfer roller **30** and the roller unit holder **40**. The roller unit holder **40** may include a secondary transfer cleaning mechanism such as a cleaning blade **39**, a solid lubricant **41**, a lubricant pressing device **43**, etc.

The surface **30***a* of the secondary transfer roller **30**, which contacts the belt surface **21***a* of the intermediate transfer belt **21** bearing a toner image serves as a contact surface to attract toner on the belt surface **21***a*. When such attracted toner is left as is, it is transferred onto a rear side of the recording medium P to cause rear side stein. To resolve such a problem, an edge of a cleaning blade **39** contacts the surface **30***a* of the second transfer roller **30** to physically remove the toner therefrom. However, with such a configuration, contact of the cleaning blade **39** causes a load on the secondary transfer roller **30** to impede rotation thereof, so that the secondary transfer roller **30** cannot be driven and rotated by the intermediate transfer belt **21**. Therefore, the secondary transfer roller **30** is driven and rotated by the above-described roller driving motor.

A lubricant pressing device **43** presses the solid lubricant **41** composed of zinc stearate lump or the like against the surface **30***a* of the secondary transfer roller **30** with the bias coil spring **42** and thereby coating the surface with the lubricant powder. Consequently, a rotational load and winding up of an edge of the blade, generally caused by the contact between the cleaning blade **39** and the surface **30***a* of the secondary transfer roller **30**, can be suppressed. Instead of pressing the solid lubricant **41** against the surface **30***a* of the secondary transfer roller **30**, a rotation coating brush can be employed to scrape the solid lubricant **41** and at same time coats it to the surface **30***a* of the secondary transfer roller **30**.

Now, an exemplary distinguishing configuration of the transfer unit **20** and copier is described. When a leading end of a recording medium plunges into or just when the trailing end thereof exits from the secondary transfer nip N formed between the belt surface **21***a* of the intermediate transfer belt **21** and the surface **30***a* of the secondary transfer roller **30**, impact conventionally is applied to the intermediate transfer belt **21** and changes a velocity of the intermediate transfer belt **21**. Consequently, an image forming apparatus is recently demanded to especially increase usability to accommodate various sheet types of recording mediums P. As a result, when a cardboard having a basic weight of about 300 g/m^2 is used as a recording medium P, the impact increases and causes impact jitter as a serious problem.

As a device to resolve such a problem, a first embodiment is described with reference to FIG. **3**, wherein an enlarged cross sectional view of surroundings of a secondary transfer nip N of the transfer unit **20** is described.

As shown, the secondary transfer roller **30** includes a roller section **31** extending in a widthwise direction perpendicular to that of a recording medium member conveyance, a pair of first and second shaft members **32** and **33** protruding from both ends and extending in a rotation shaft direction, and first and second idling rollers **34** and **35**. The roller section **31** includes a hollow cylindrical metal core **31***a*, an elastic layer **31***b* overlying the circumference of the metal core **31***a*, and a surface layer **31***c* overlying the circumference of the elastic layer **31***b*.

Material of the metal core **31***a* includes stainless, aluminum, and the like, but is not limited thereto. The elastic layer **31***b* preferably has a prescribed JIS-A hardness equal to or less than about 70 degree. However, since the cleaning blade **39** contacts the roller section **31**, various problems can be induced if the elastic layer **31***b* is too soft. Consequently, the JIS-A hardness of the elastic layer **31***b* is preferably equal to or less than about 40 degree. Otherwise, the elastic layer **31***b* can have a JIS-A hardness of about 50 degree and is made of epichlorohydrin rubber having a certain amount of conductivity. Instead of the epichlorohydrin rubber, EPDM and Si rubber with dispersion of carbon, NBR having an ion conducting function, and urethane rubber or the like can be employed to have conductivity. Since many rubbers have a preferable chemical affinity for toner and a relatively large friction coefficient, the surface of the elastic layer **31***b* is covered with a surface layer **31***c*. Consequently, an amount of toner attracted to the surface of the roller section **31** and a sliding load on the cleaning blade **39** are decreased. As material of the surface layer **31***c*, fluorine resin having a preferable toner releasing performance at a low friction coefficient is preferably used by including resistance adjuster, such as carbon, ion conductive agent, etc.

A line speed of the secondary transfer roller **30** is sometimes slightly different from that of the belt surface **21***a* when rotating while contacting the belt surface **21***a*. To avoid slipping of the belt caused by the slight difference in line speed, a friction coefficient of the surface layer **31***c* is adjusted to be equal or less than 0.3. Because, since the intermediate transfer belt **21** is expected to move at a constant speed to transfer and superimpose respective color images without deviation therebetween, desecrating in the surface friction resistance of the surface layer **31***c* is important. The secondary transfer roller **30** with the above-described configuration is biased by the bias coil spring **45** toward the intermediate transfer belt **21** wound around the secondary transfer opposed roller **24** as shown in FIG. **2**.

The secondary transfer opposed roller **24** includes a roller section **24***b* composed of a cylindrical column body, and a penetration shaft member **24***a* that penetrates through a rotation center in its rotational axis direction to allow the roller section **24***b* to execute idling rotation therearound. The penetration shaft member **24***a* is made of metal and freely rotatably supports the roller section **24***b* on its circumference to allow it to execute idling rotation. The roller section **24***b* serving as a body section includes a drum state hollow metal core **24***c*, an elastic layer **24***d* made of elastic member firmly disposed on a circumference of the hollow metal core **24***c*, a pair of ball bearings **24***e* inserted with pressure into both ends of the hollow metal core **24***c* in the axial direction. Thus, the ball bearing **24***e* rotates on the penetration shaft member **24***a* together with the hollow metal core **24***c* while supporting thereof. An elastic layer **24***d* is inserted with pressure into an outer circumferential surface of the hollow metal core **24***c*.

The penetration shaft member **24***a* is freely rotatably supported by first and second bearings **52** and **53** firmly disposed on first and second side plates **28** and **29** of the transfer unit **20** that stretches the intermediate transfer belt **21**, respectively. However, the penetration shaft member **24***a* stops almost all the time during a printing job without being driven and rotated, and allows the roller section **24***b* tending to be driven as the intermediate transfer belt **21** endlessly moves to freely execute idling rotation on its circumference.

The elastic layer **24***d* firmly disposed on the circumference of the hollow metal core **24***c* is made of conductive rubber with its resistance being adjusted by adding conductive agent thereto to have a resistance equal to or more than 7.5 Log Ω (Ohm). An electric resistance of the elastic layer **24***d* is adjusted in a prescribed range as described earlier to avoid concentration of transfer current at a section where the belt surface **21***a* directly contacts the roller surface in the secondary transfer nip N when a recording medium having a relatively small size in the roller shaft direction, such as A5 size (JIS), etc., is used. Such concentration of the transfer current can be suppressed by increasing an electric resistance of the elastic layer **24***d* to be greater than that of the recording medium P.

Foam rubber having an Asker-C hardness of about 40 degree can be used as the conductive rubber material of the elastic layer **24***d*. Using such elastic layer **24***d* made of the foam rubber, a thickness of the elastic layer **24***d* is flexibly changed in the thickness direction in the secondary transfer nip N, so that the secondary transfer nip N can have a wide range in the recording medium conveyance direction to the some extent. The elastic layer **24***d* is a drum state having a larger outer diameter at its center than that of the side ends. As a result, the secondary transfer opposed roller **24** is a drum state having smaller outer diameter at its both ends **24**B and **24**C than that at the center **24**A thereof. By employing such a drum shaped roller, neither bending occurs nor pressure is lost due to the bending when the secondary transfer roller **30** is biased toward the intermediate transfer belt **21** and forms the second transfer nip N thereon.

Further, as described with reference to FIG. **2**, for the convenience of engaging the cleaning blade **39** with the secondary transfer roller **30**, elasticity enriched material is rarely employed in the roller section of the secondary transfer roller **30**. Consequently, instead of the secondary transfer roller **30**, the roller section **24***b* of the secondary transfer opposed roller **24** is enabled to elastically deform.

The penetration shaft member **24***a* of the secondary transfer opposed roller **24** includes striking members striking with the secondary transfer roller **30** at both ends thereof in the lengthwise direction deviated from the roller section **24***b*. Specifically, a pair of cams **50** and **51** is secured to the both ends of the penetration shaft member **24***a* to integrally rotate with the penetration shaft member **24***a* as a part of an engaging and disengaging device. Specifically, the first cam **50** is secured to one of the ends in the lengthwise direction of the penetration shaft member **24***a*. The cam **50** includes a cam section **50**A and a perfect circular roller section **50**B integrated in the shaft direction side by side. The cam **50** is secured to the penetration shaft member **24***a* by screwing a screw **80** penetrated into the roller section **50**B into the penetration shaft member **24***a*. The cam **51** similarly includes a cam section **50**A and a perfect circular roller section **50**B integrated in the shaft direction side by side, and is secured to the other side end region of the penetration shaft member **24***a* in the lengthwise direction thereof with the same configuration as the cam **50**. A driving reception pulley **54** is secured to a region of the penetration shaft member **24***a* outside the cam **51** in the shaft direction. A detection target disc **59** is secured to a yet outside of the driving reception pulley **54**.

A cam driving motor **58** for driving and rotating the cams **50** and **51** both in normal and reverse rotation directions is disposed on the second side plate of the transfer unit **20**. The cam driving motor **58** rotates a motor pulley **57** disposed on its output shaft and transmits a driving force to the driving reception pulley **54** secured to the penetration shaft member **24***a* via a timing belt **56**. With such a configuration, when the cam driving motor **58** operates, the penetration shaft member **24***a* can be rotated. Even when the penetration shaft member **24***a* is rotated, the roller section **24***b* can be driven by the intermediate transfer belt **21** without being disturbed, because the roller section **24***b* can freely execute idling rotation on the penetration shaft member **24***a*. Further, as the cam driving motor **58**, a stepping motor or the like is used to freely designate a motor rotation angle omitting a rotation angle detection device, such as an encoder, etc. Of course, the rotation angle detection device can be employed to detect a rotation angle of the cam driving motor.

Outer circumferential surfaces **50**C and **51**C of the cams **50** and **51** are formed, so that cam sections **50**A and **51**A bump into and push the secondary transfer roller **30** back against a bias force of the bias coil spring **45** of the roller unit holder **40** when the penetration shaft member **24***a* rotates and stops at a prescribed rotation angle. Specifically, by adjusting rotation positions of the cams **50** and **51** and thereby moving the secondary transfer roller **30** in the vicinity of the secondary opposed roller **24** (ultimately to the intermediate transfer belt **21**), a shaft interval L between the secondary transfer roller **30** and the secondary opposed roller **24** is adjusted. Further, when the shaft interval L is adjusted, a gap X between the surface **30***a* of the secondary transfer roller **30** and that **21***a* of the secondary transfer belt **21** can be adjusted.

In this embodiment, the shaft interval L between the secondary transfer roller **30** and the secondary opposed roller **24** is adjusted at least by the cams **50** and **51** as well as the cam driving motor **58**. Specifically, an engaging and disengaging device **500** for engaging and disengaging the surface **21***a* of the intermediate transfer belt from the surface of the secondary transfer roller **30** is provided. The secondary transfer opposed roller **24** serves as a freely rotatable support member and allows the cylindrical column state roller section **24***b* to freely execute idling rotation on the penetration shaft member **24***a* penetrated therethrough. Since the cams **50** and **51** secured to the both ends of the penetration shaft member **24***a* in the axial direction thereof integrally rotate when the penetration shaft member **24***a* rotates, the cams **50** and **51** on the both ends can be rotated with a driving transmission mechanism only on one end thereof in the axial direction.

The hollow metal core **31***a* of the secondary transfer roller **30** is grounded and a secondary transfer bias having the same polarity as toner is applied to the hollow metal core **24***c* of the secondary transfer opposed roller **24** in this copier. Thus, a second transfer electric field is created between these rollers in the secondary transfer nip N to electrostatically move toner from the secondary transfer opposed roller **24** to the secondary transfer roller **30**. Specifically, the first bearing **52** freely supporting the penetration shaft member **24***a*, which is made of metal and included in the secondary transfer opposed roller **24**, includes a conductive sliding bearing. A high voltage power source **61** is connected to the first bearing **52** to output a secondary transfer bias as a transfer device. The secondary transfer bias outputted from the high voltage power source **61** is supplied to the secondary transfer opposed roller **24** via the first conductive bearing **52**. Then, the secondary transfer bias travels the penetration shaft member **24***a* made of metal, a ball bearing **24***e* made of metal, a hollow metal core **24***c*, and a conductive layer **24***d* made of metal in this order in the secondary transfer opposed roller **24**.

The detection target disc **59** secured to one end of the penetration shaft member **24***a* includes a detection target section **59***a* rising in an axial direction at a prescribed position in the rotational direction of the penetration shaft member **24***a*. Further, an optical sensor **60** serving as a detection device is secured to a sensor bracket **501** secured to the second side plate **29** of the transfer unit **20**. When the penetration shaft member **24***a* rotates and positions within a prescribed rotation angular range, the detection target section **59***a* of the detection target disc **59** enters between the light emitting and receiving elements and cuts off an optical path therebetween during rotation thereof. The light reception element of the optical sensor **60** transmits a light reception signal to a controller **600** upon receiving the light from the light emitting element.

The controller **600** includes a known computer and is connected to the optical sensor **60** and the cam driving motor **58**. The controller **600** calculates a time when a reception signal from the light reception element of the optical sensor disappears or a driving amount of the cam driving motor **58** based on the time, and activates the cam driving motor **58**. The controller **600** further detects rotation angles of the cams **50** and **51** secured to the penetration shaft member **24***a* and stops them at prescribed positions as described later with reference to FIG. **4** and subsequent drawings.

These cams **50** and **51** bump into the secondary transfer roller **30** at a prescribed rotation angle and push it back against the bias of the bias coil spring **45** away from the secondary transfer opposed roller **24** (hereinafter referred to as depression). At that moment, an amount of pushing back (hereinafter referred to as depression) is determined based on the rotation angles (i.e., positions) of the cams **50** and **51**. Specifically, the larger the pushing down amount of the secondary transfer roller **30** by these cams **50** and **51**, the larger the shaft interval L between the secondary transfer roller **30** and secondary transfer opposed roller **24**.

A first idling roller **34** is capable of freely executing idling rotation and is disposed on the first shaft member **32** that integrally rotates with the roller section **31**. The first idling roller **34** has a doughnut disc shape having a slightly larger outer diameter than that of the roller section **31**, and function as a ball bearing by itself, and is capable of executing idling rotation on the circumferential surface of the first shaft member **32**. A second idling roller **35** with the same configuration as the first idling roller **34** is disposed on the second shaft member **33** of the secondary transfer roller **30**.

The cams **50** and **51** secured to the penetration shaft member **24***a* include prescribed outer circumferential surfaces **50**C and **51**C enabling to strike the idling rollers **34** and **35** at prescribed rotation angle positions in the secondary transfer opposed roller **24**. Specifically, a cam section **50**A of the first cam **50** secured to one end of the penetration shaft member **24***a* strikes the first idling roller **34** of the secondary transfer roller **24**. At that moment, a cam section **51**A of the second cam **51** secured to the other end of the penetration shaft member **24***a* strikes the second idling roller **35** of the secondary transfer roller **24**. The idling rollers **34** and **35** plunged into by the cams **50** and **51** are interrupted to rotate accordingly. However, rotation of the secondary transfer roller **30** is not interrupted. Because, the idling rollers **34** and **35** have the bearings **32** and **33**, and thus the shaft members **32** and **33** of the secondary transfer roller **30** can freely rotate independently from the idling rollers **34** and **35** even when the idling rollers **34** and **35** stop rotating. Further, by stopping rotation of the idling rollers **34** and **35** as the cam sections **50**A and **51**A plunges thereinto, a friction and accordingly a torque of driving motors driving the belt and the secondary transfer roller **30** increased due to the friction can be suppressed.

Now, exemplary features and operations of the cams **50** and **51** are described with reference to FIGS. **4** to **11**. As shown, the cams **50** and **51** each include a prescribed shape providing two different displacements, so that four different cam positions A to D can be designated.

The cam positions A and C correspond to the outer diameters of the cam. The cam positions B has a deviation amount δ (Delta)=1 mm (i.e., 1 mm greater than the cam positions A and C), whereas the cam positions D has a deviation amount (Delta)=0.7 mm (i.e., 0.7 mm greater than the cam positions A and C).

Thus, when the cam positions B and D contact the idling rollers **34** and **35** on the secondary transfer roller shaft, the secondary transfer roller is pushed down (depressed), so that a surface distance between the surface **24***a* of the secondary transfer roller **254** and that **30***a* of the secondary transfer opposed roller **24** can be changed. An outer diameter of the cam is determined not to depress the secondary transfer roller at the cam positions A and C. Specifically, the cams **50**A and **51**A include cam portions **50***a* and **51***a* and **50***b* and **51***b* at the cam positions B and D, respectively.

As shown in FIG. **5**, deviation profiles of the cams **50** and **51** are each symmetrical. Specifically, by equalizing the deviation profile formed from the cam position A center to the cam position B center with that formed from the cam position B center to the cam position C center, the same deviation can be obtained regardless of the rotational direction of the cams **50** and **51** from the cam position B center. Similarly, the deviation profile formed from the cam position C center to the cam position D center with that formed from the cam position D center to the cam position A center is equalized.

As shown in FIG. **6**, when a plain paper P**1** enters a secondary transfer nip N, a cam driving motor **58** is controlled by the controller **600** to stop the penetration shaft member **24***a* of the secondary transfer opposed roller **24** at a prescribed position where the cams **50** and **51** of the secondary transfer opposed roller **24** do not strike the idling rollers **34** and **35** of the secondary transfer roller **30** (i.e., a position where the cam position C is directed downward). Specifically, when the plain paper is used, the cams **50** and **51** do not execute depression of the secondary transfer roller **30**. That is, when a relatively thin plain paper P**1** enters the secondary transfer nip N, a large load is not generated on the intermediate transfer belt **21** and the secondary transfer roller **30** even if the secondary transfer roller **30** is not depressed.

When a cardboard P**2** enters the secondary transfer nip N, the controller **600** controls the cam driving motor **58** to stop rotation of the penetration shaft member **24***a* of the secondary transfer opposed roller **24** at a position where the cams **50** and **51** of the secondary transfer opposed roller **24** strike the idling rollers **34** and **35** (i.e., the cam position B) as shown in FIG. **7**. Specifically, when the cardboard P**2** is used, the depression of the secondary transfer roller **30** by the cams **50** and **51** is executed to obtain the surface gap X between the surfaces **30***a* and **21***a* of the secondary transfer roller **30** and the intermediate transfer belt **21**, respectively.

With such control, even the thick cardboard P**2** enters the secondary transfer nip N, a load hardly changes and impact jitter rarely occurs on the intermediate transfer belt **21** and the secondary transfer roller **30**.

However, a sufficient nip pressure cannot be obtained for transferring, thereby decreasing a transfer performance of a toner image. Especially, when a recording medium having poor surface smoothness is used, a transfer ratio significantly deteriorates. Accordingly, the controller **600** controls the cam driving motor **58** to rotate the cams **50** and **51** clockwise and stops it at a position where the cam position C is directed downward to rotate the penetration shaft member **24***a* of the secondary transfer opposed roller **24**, so that the cams **50** and **51** of the secondary transfer opposed roller **24** come to positions where the cams **50** and **51** do not strike the idling rollers **34** and **35** of the secondary transfer roller **30** right after the recording medium enters the secondary transfer nip N as shown in FIG. **8**. Such rotation needs to start driving after the recording medium enters the secondary transfer nip N and is completed before a toner image comes thereto.

During an image transfer process, the cams **50** and **51** of the secondary transfer opposed roller **24** are kept out of positions where the cams **50** and **51** do not strike the idling rollers **34** and **35** (i.e., a position where the cam position C is directed downward). Specifically, the cam driving motor **8** stops driving at the time. As shown in FIG. **9**, the controller **600** controls the driving motor **58** to rotate the cams **50** and **51** of the secondary transfer opposed roller **24** in an opposite direction (e.g. counter clockwise) from when an image on the belt surface **21***a* of the intermediate transfer belt **21** is transferred to when a trailing end of the recording medium (e.g. a cardboard P**2**) exits from the secondary transfer nip N. The controller **600** then stops the driving motor **58** to located the cams **50** and **51** at a position (i.e., a cam position B) to strike the idling rollers **34** and **35** of the secondary transfer roller **30**.

That is, since the thick cardboard P**2** also causes a significant change in load on the intermediate transfer belt **21** and the secondary transfer roller **30** when quitting from the secondary transfer nip N, the secondary transfer roller **30** is similarly depressed as executed when entering thereto to avoid the problem.

Subsequently, the cam driving motor **58** and accordingly the cam are stopped so that the cam position B is directed downward and the secondary transfer roller **30** is depressed until a leading end of the next recording medium enters the secondary transfer nip N. As a result, the change in load on the intermediate transfer belt **21** and the second (subsequent) transfer roller **30** caused when the second sheet of the recording medium enters the secondary transfer nip N can be suppressed as obtained in the first (precedent) sheet thereof.

After entrance of the leading end of the second sheet into the nip, the controller **600** controls the cam driving motor **58** to rotate the cams **50** and **51** in an opposite direction (i.e., counter clockwise) to that the leading end of the first sheet enters. Specifically, the cams **50** and **51** of the secondary transfer opposed roller **24** is rotated to a position do not strike the idling rollers **34** ad **35** of the secondary transfer roller **30** (i.e., a position where the cam position A is directed downward).

Thus, as shown in FIGS. **4** and **5**, by changing the movement position of the cams **50** and **51** in the first and second sheet passages, durability against abrasion of the cam surface and driving section of the cams **50** and **51** can be improved.

That is, when the deviation profiles are not symmetric, e.g. “a” and “b” or “c” and “d” in FIG. **4**, normal and reverse rotations are repeatedly used with one of inclinations of “a” and “b”, or “c” and “d”, so that their lives are almost halved. Further, depending on a basic weight of the recording medium, a significant change sometimes occurs in belt speed when a few moments has elapsed after a leading end of a sheet plunges into the nip. For example, when a recording medium having a basic weight of 300 g/m^2 passes through the secondary transfer nip N when the cams **50** and **51** stop at the cam position B with a deviation amount of 1 mm, a change does not occur in speed of the intermediate transfer belt **21** from when it enters to when it exits. By contrast, when a recording medium having a basic weight of 160 g/m^2 passes through the secondary transfer nip N when the cams **50** and **51** stop at the cam position B (with a deviation amount of 1 mm), the change occurs in speed of the intermediate transfer belt **21**. That is, when the cams **50** and **51** that depresses the secondary transfer roller **30** rotate and the depression of the secondary transfer roller **30** is thereby released, vibration caused by contact between the secondary transfer roller **30** and the secondary transfer opposed roller **24** via the intermediate transfer belt **21** induces a change in speed of the intermediate transfer belt **21**.

Then, the cam position is change to the position D having an amount of deviation of 0.7 mm to decrease a depression amount of the secondary transfer roller **30** and suppress the vibration caused when the depression is released. However, since the depression amount is small when the basic weight of the recording medium is about 300 g/mm^2 as different from when it is 160 gmm^2, a change in speed occurred in the intermediate transfer belt **21** falls within an allowable range when entering the nip P, but an image is disturbed.

Thus, since a depression amount is preferably changed in accordance with a thickness of the recording medium, a thickness information acquiring device **700** is disposed in the copier to acquire thickness information of the recording medium conveyed to the secondary transfer nip N as shown in FIG. **3**. As a thickness acquiring device **700**, a thickness detection sensor is employed to practically detect a thickness of a sheet conveyed on a sheet passage **99**. Otherwise, a data input device may be employed to receive data related to thickness inputted by an operator. As a thickness sensor, an optical sensor that detects a light transmission ratio in a thickness direction or a sensor that detects an amount of displacement of rollers when a sheet is pinched therebetween can be employed.

The controller **600** is enabled to adjust a depression amount of the secondary transfer roller **30** in accordance with a result of acquisition by the thickness information acquiring device **700**. Specifically, a data table representing a relation between thickness information and a corresponding rotation stop position of the penetration shaft member **24***a* (i.e., an amount of depression) is stored in data storage, such as a ROM, etc., in the controller **600**. Then, a corresponding rotation stop position of the penetration shaft member **24***a* to the thickness of the recording medium is specified from the data table, and the cam driving motor **58** is operated to rotate the penetration shaft member **24***a* to the rotation stop position as specified. Further, the controller is enabled to start entrance of the recording medium into the secondary transfer nip N after determining stopping positions of the multi step cams **50** and **51**. By suitably designating a secondary transfer depression amount for the thickness of the recording medium with the above-described device, impacts generally generated when the recording medium enters or depression is released can be suppressed.

The controller **600** recognizes a rotation stop position of the penetration shaft member **24***a* based on a time when the optical sensor **60** detects a detection target section **59***a* of the detection target disc **59** or a driving amount of a stepping motor serving as a cam driving motor **58** after the time.

Hence, a situation where the cams **50** and **51** are disposed on the side of the secondary transfer opposed roller **24** to adjust a surface distance (i.e., a gap X) between the belt surface of the intermediate transfer belt **21** wound around the secondary transfer opposed roller **24** and the secondary transfer roller **30** is described heretofore. However, such a gap X can be adjusted by another system. For example, a depressing member is disposed on the roller unit holder **40** so that the cams **50** and **51** adjust the surface distance (i.e., the gap X) between the belt surface **21***a* and the secondary transfer roller **30**.

Now, an exemplary relation among a recording medium, a cam position, and a pattern for adjustment is described. The pattern is formed to adjust density and positional deviation, and to avoid twisting of a blade or the similar and any other purposes as far as it is formed as an image corresponding to an interval between sheets.

FIGS. **10**A and **10**B typically collectively illustrate an exemplary second transfer position in an interval between sheets and an image position on an intermediate transfer belt **21** when multiple recording mediums successively pass therethrough. In particular, FIG. **10**A illustrates an exemplary condition when an image T formed on an intermediate transfer belt **21** is transferred onto a previous recording medium Pa at a secondary transfer nip. At that moment, before the next image arrives, that is, the adjustment pattern T**1** is formed on the belt surface **21***a* of the intermediate transfer belt **21** corresponding to an interval between sheets. Subsequently, when a recording medium currently subjected to a transfer process is ejected, the above-described cams **50** and **51** rotate and the surface distance between the secondary transfer roller **30** and the belt surface **21***a* is broadened. FIG. **10**B illustrates an exemplary condition when a leading end of the next recording medium enters the secondary transfer nip when an adjustment pattern has passed therethrough.

Then, as shown in FIG. **10**B, when a leading end of the subsequent recording medium Pb enters the secondary transfer nip N after the adjustment pattern T**1** has passed, the cams **50** and **51** are rotated again to contact the first and second idling rollers **34** and **35**. A sequence of the recording medium Pb having a basic weight of 300 g/mm^2, an image, and a cam position at that time is illustrated in FIG. **11**.

The controller **600** controls an operation of the cam driving motor **58** and accordingly rotation of the penetration shaft member **24***a* to provide the cam position D where a deviation amount δ (delta) is small (e.g. 0.7 mm) when an adjustment pattern T1 is formed corresponding to an interval between sheets. Specifically, the cams **50** and **51** are initially located at a position A, so that the secondary transfer roller **30** and the belt surface **21***a* of the intermediate transfer belt **21** contact each other as shown in FIG. **11**. Then, the cams **50** and **51** rotate and are located at the position B, serving as a separation position for a recording medium having 300 gmm^2, and disengages the secondary transfer roller **30** from the belt surface **21***a* of the intermediate transfer belt **21** before the recording medium enters therebetween. Subsequently, the cams **50** and **51** rotate again and are located at the position C to engage the secondary transfer roller **30** with the belt surface **21***a* when the next recording medium has entered, thereby transferring an image onto a recording medium. Then, the cams **50** and **51** rotate before ejection of the sheet, so that the secondary transfer roller **30** is disengaged from the transfer belt surface **21***a*. At that time, the cams **50** and **51** generally are located at the position B. However, since the adjustment pattern is formed corresponding to the interval between the sheets, the cams **50** and **51** are located at the position D having smaller deviation amount δ (delta) and make the above-described separation. After passage of the adjustment pattern through the secondary transfer nip N under separation condition and before entrance of a leading end of the next recording medium, the cams **50** and **51** rotate and are located at the position A and make the above-described contact, thereby transferring the image onto the recording medium. Specifically, the cams **50** and **51** are driven by the cam driving motor **58** controlled by the controller **600** to rotate and change four positions from A to D in this order.

With such a configuration, since toner is not transferred onto the secondary transfer member (i.e., an intermediate transfer belt **21**) in an interval between sheets, a secondary transfer cleaning mechanism can be omitted, thereby downsizing an apparatus. Further, by using the engaging and disengaging device **500** as a pushing down mechanism, a change in speed can be suppressed when a leading end of a sheet enters and a trailing end thereof exits therefrom. As a result, a poor image is not generated.

Now, a second embodiment, in particular an exemplary sequence of a recording medium, an image and a cam position is described with reference to FIG. **12**.

Different from the first embodiment even with the same configuration, a separation amount is controlled in accordance with a thickness of a recording medium when an adjustment pattern is similarly formed between sheets. In this embodiment, the controller **600** controls an operation of a cam driving motor **58** and rotation of cams **50** and **51** such that cam positions changes in an order of A, B, C, and B.

An exemplary sequence of the recording medium having a basic weight of about 300 gmm^2, an image, and a cam position is described. Initially, the cams **50** and **51** are located at a position A, so that the secondary transfer roller **30** and the belt surface **21***a* of the intermediate transfer belt **21** contact each other as shown in FIG. **11**. Then, the cams **50** and **51** rotate and are located at the position B, serving as a separation position for a recording medium having 300 gmm^2, and disengages the secondary transfer roller **30** from the belt surface **21***a* of the intermediate transfer belt **21** before the recording medium enters therebetween. Subsequently, the cams **50** and

51 rotate again and are located at the position C to engage the secondary transfer roller **30** with the belt surface **21***a* when the next recording medium has entered, thereby transferring an image onto a recording medium. Then, the cams **50** and **51** rotate before ejection of the sheet and disengages the secondary transfer roller **30** from the transfer belt surface **21***a*. Even though the cams **50** and **51** are moved to the position D because the adjustment pattern is formed corresponding to the interval between the sheets in the first embodiment, they are moved to position B and disengage those as in the second embodiment. After passage of the adjustment pattern through the secondary transfer nip N under the separation condition and before entrance of a leading end of the subsequent sheet, the cams **50** and **51** rotate and are located at the position A and make the above-described contact, thereby transferring the image onto the recording medium.

With such a configuration, since toner is not transferred onto the secondary transfer member (i.e., an intermediate transfer belt **21**) in an interval between sheets as in the first embodiment, a secondary transfer cleaning mechanism can be omitted, thereby downsizing an apparatus. Further, using the engaging and disengaging device **500** as a pushing down mechanism, a change in speed can be suppressed when a leading end of a sheet enters and a trailing end thereof exits therefrom. As a result, a poor image is not generated.

Now, a third embodiment is described with reference to FIG. **6**, wherein a secondary transfer bias is turned off when an adjustment pattern is formed corresponding to an interval between sheets as only different from the second embodiment. Since the configuration of the apparatus is substantially the same as the first embodiment, only a difference of a relation between a sheet, a cam position, and a secondary transfer bias is described.

First, a repelling force transfer system is employed such that a secondary transfer bias is subjected to constant current control in an image section, while a bias having the same polarity as toner (e.g. a negative polarity) is applied to a secondary transfer opposed roller **24**. Further, a constant voltage control is applied to a secondary transfer bias used for a non-image section and rotation of a cam. Such control of a secondary transfer bias is executed by connecting the controller **600** to a high voltage power source **61** with a signal line to control the high voltage power source **61** as shown in FIG. **15**.

FIG. **16** illustrates an exemplary sequence of sheets, images, positions of a cam, and a secondary transfer bias when two sheets of cardboard are fed. Specifically, the repelling force transfer system is employed in which a secondary transfer bias is subjected to constant current control in an image section, while a bias having the same polarity as toner (e.g. a negative polarity) is applied to a secondary transfer opposed roller **24**. Further, a constant voltage control is applied to a secondary transfer bias used for a non-image section and rotation of a cam.

When printing for a first sheet is started, the secondary transfer roller **30** contacts the intermediate transfer belt **21**, while the cams **50** and **51** are located at the position A. At that moment, a secondary transfer bias (e.g. +500V) is applied to a non-image section Subsequently, when a cardboard P**2** approaches the secondary transfer nip N, the cams **50** and **51** start moving to the position B (generating a deviation amount of 1 mm). The secondary transfer bias changes a level (e.g. +200V) for a cam rotation in synchronizing with rotation of the cams **50** and **51**. When the cams **50** and **51** arrive at the position B, the secondary transfer roller **30** disengages from the secondary transfer opposed roller **24**. Then, a cardboard P**2** is conveyed in such a separation condition. At the same time when the cardboard P**2** arrives at the secondary transfer nip N, i.e., a leading end of the cardboard P**2** enters thereof, the cams **50** and **51** start normal rotation clockwise, for example.

When a leading end of an image arrives at the secondary transfer nip N, the cams **50** and **51** move and stop at the position C. At the same time, the secondary transfer roller **30** contacts the secondary transfer opposed roller **24**. The secondary transfer bias receives the constant current control, thereby becoming an image section current (e.g. −30 micro-ampere, and −1000V of voltage application).

Subsequently, printing is performed by applying the image section transfer current under the condition that the secondary transfer roller **30** contacts the secondary transfer opposed roller **24**. When a trailing end of the image arrives at the secondary transfer nip N, the cams **50** and **51** start reversing motion counter clockwise to execute separation. Synchronizing with the start of the reversing motion, the secondary transfer bias is changed to the cam rotation bias under the constant voltage control from the image section bias executed under the constant current control. Since an adjustment pattern is formed corresponding to an interval between sheets, the secondary transfer bias is tuned off to be nothing (i.e., zero). At that moment, the secondary transfer application voltage for the image section is −1000V, whereas that for a time when the adjustment pattern passes therethrough is zero volts. Specifically, an absolute value of the voltage applied when the adjustment pattern passes therethrough is smaller than that for the image section. When the trailing end of the sheet arrives at the secondary transfer nip N, the cams **50** and **51** move and stop at the position B. At that moment, the cam rotation bias is ordinarily switched to the non-image section bias in synchronism with the stop of motion of the cams. However, to form the adjustment pattern in an interval between sheets, the secondary transfer bias is nothing (i.e., zero) as in the cam rotation time period. Specifically, the adjustment pattern formed between sheets pass therethrough under the condition that the secondary transfer bias is turned off and the secondary transfer roller **30** disengages from the secondary transfer opposed roller **24**.

Subsequently, the second sheet is conveyed to the secondary transfer nip N. When the leading end of the sheet arrives at the secondary transfer nip N, the cams **50** and **51** rotate to a opposite direction to that for the first sheet, i.e., counter clockwise, and the secondary transfer bias is synchronously changed to the cam rotation time period bias. However, the secondary transfer bias remains zero volts for the interval between sheets bearing the adjustment pattern. Subsequently, as executed in the first sheet, the second sheet printing is executed by disengaging and engaging the secondary transfer roller **30** with the secondary transfer opposed roller **24** and switching the secondary transfer bias synchronizing with the rotation of the cams. When the final sheet is printed, the cams **50** and **51** move and stop at the position C. At that moment, the non-image section bias is turned off and the printing is completed in synchronism with the stop of the cams.

According to the third embodiment, since toner is not transferred onto the secondary transfer member (i.e., an intermediate transfer belt **21**) in an interval between sheets as in the first embodiment, a secondary transfer cleaning mechanism can be omitted, thereby downsizing an apparatus. Further, the depression mechanism provides a deviation amount in accordance with a thickness of sheet P**2**, a change in speed can be suppressed when the leading end of the sheet enters and the trailing end thereof exits therefrom. As a result, a poor image is not generated.

Now, a fourth embodiment is described with reference to FIG. **17**, wherein an opposite bias to that applied when a toner image is transferred onto a sheet is applied when an adjustment patter is formed corresponding to an interval between sheets as different from that in the third embodiment.

Such a bias control is executed by a controller **600** that also controls a high voltage power source **61**. Since a configuration of the apparatus and a time for applying a secondary transfer bias are the same to those in the third embodiment, description for them are omitted hereinafter, and a secondary transfer bias applied when an adjustment pattern is formed between sheets is only described.

FIG. **17** illustrates a sequence of a sheet, an image, a position of a cam, and a secondary transfer bias when two sheets of cardboard are fed in a system similar to that in the third embodiment. When image printing for the first sheet is completed, an adjustment pattern is formed corresponding to an interval between first and second sheets. Then, under a condition that the secondary transfer roller **30** contacts the secondary transfer opposed roller **24** via the intermediate transfer belt **21** and an image section current of −30 microA and −1000V of application voltage is applied, the first sheet is printed. When a trailing end of an image arrives at a secondary transfer nip N, the cams **50** and **51** start a reverse motion counter clockwise to are located at the position B and execute separation. In synchronism with the start of the reversing motion, the image section bias generated under the control of constant current is switched to the cam rotation time period bias generated under the control of the constant voltage. Specifically, an opposite bias to that applied during the sheet transfer time period is applied during a cam rotation time period at about +200V.

At that moment, the secondary transfer application voltage is −1000V in the image section. Whereas, it is +200V in the cam rotation time period. Specifically, the absolute voltage of the cam rotation time period is smaller than that for the image section. When the trailing end of the sheet arrives at the secondary transfer nip N, the cams **50** and **51** move and stop at the position B. At that moment, in synchronism with motion stop of the cams, the cam rotation time period bias is switched to the non-image section bias to prepare for passage of the adjustment pattern corresponding to an interval between sheets. The non-image section bias is opposite to that for the sheet transfer and is +500V. Thus, it is also smaller than the application voltage of −1000V for the image section.

Thus, the adjustment pattern formed corresponding to an interval as a result of the above-described operation passes through under conditions that the opposite secondary transfer bias to that for the sheet transfer is applied and the secondary transfer roller **30** disengages from the secondary transfer opposed roller **24**.

When a leading end of the second sheet arrives at the secondary transfer nip N, the cams **50** and **51** start reverse rotation counter clockwise to the rotation for the first sheet. In synchronism with the start of the reversing motion, the secondary transfer bias is changed to the cam rotation time period bias of +200V. When the sheet has entered, in synchronism with driving of the cams, the cam rotation time period bias is changed to the image section bias. Then, the second sheet is printed and the printing is terminated.

According to the fourth embodiment, since toner is not transferred onto the secondary transfer member (i.e., an intermediate transfer belt **21**) in an interval between sheets as in the third embodiment, a secondary transfer cleaning mechanism can be omitted, thereby downsizing an apparatus. Further, the depression mechanism provides a deviation amount in accordance with a thickness of sheet P**2**, a change in speed can be suppressed when the leading end of the sheet enters and the trailing end thereof exits therefrom. As a result, a poor image is not generated.

Now various comparative examples are described.

The first comparative example has the almost same configuration as the first embodiment but excludes the engaging and disengaging device **500** serving as the depressing mechanism for the secondary transfer roller. Thus, since the secondary transfer roller **30** always contacts the surface **21***a* of the intermediate transfer belt **21** when an image is printed, a cleaning mechanism is necessarily provided as shown in FIG. **13**.

The second comparative example also has the almost same configuration as the first embodiment but excludes the depressing mechanism for the secondary transfer roller, wherein the secondary transfer roller **30** always contacts the surface **21***a* of the intermediate transfer belt **21** when an image is printed. However, as shown in FIG. **2**, the cleaning blade **39** serving as a cleaning mechanism is omitted in the secondary transfer section.

The third comparative example also has almost the same configuration as the second comparative example, wherein the secondary transfer bias is turned off when an adjustment pattern is formed corresponding to an interval between sheets. Although the secondary transfer roller **30** always contacts the secondary transfer opposed roller **24**, transfer onto the secondary transfer roller **30** of the adjustment pattern is suppressed by turning off the secondary transfer bias in the interval between sheets.

Sheet passage performance is experimented using the above-described first to fourth embodiments as well as the first to third comparative examples based on the below listed conditions, and their result is obtained as shown in a table of FIG. **18**;

- Number of sheets: A3 (JIS)—10 sheets—single side,
- Adjustment Pattern: Once/three sheets—within interval between sheets,
- Sheet: Manufactured by Mondi Co., Ltd. (Color Copy: Basic Weight 300 g/mm^2) (Color Copy: Basic Weight 160 g/mm^2),
- Image Pattern: Halftone Image shown in FIG. **14**, and
- Evaluation Items: Abnormal Image in Image Section (Image deterioration by plunging of Sheet), and Stein of Rear side of Sheet.

See Table.

In the table, a circle represents absence of applicable abnormality. A triangle represents presence of abnormality, but is permissible. A crisscross represents presence of abnormality.

An abnormality of an image produced using the first to fourth embodiments falls within the permissible range, and in particular, no abnormality occurs in the second to fourth embodiments. By contrast, an image is deteriorated due to a change in speed of the intermediate transfer member caused by impact of the sheet entrance in the first comparative example. In addition to the image deterioration, rear side stein is caused by offset of the adjustment pattern formed corresponding to an interval between sheets and transferred onto the secondary transfer roller occurs in the second comparative example. Since the secondary transfer bias is turned off, an amount of the adjustment pattern formed between sheets and transferred onto the secondary transfer roller decreases than that in the second comparative example in the third comparative example.

However, the third comparative example cannot sufficiently eliminate the rear side stein.

The present invention is not limited to the copier as described heretofore, and can be applied to a facsimile, a printer, and a multi-functional system obtained by combining those of applicable devices. The image forming apparatus can be a four-cycle type or a single image bearer type rather than the tandem as described above.

Instead of the secondary transfer nip N where a recording medium P enters as described above, the present invention can be applied to another transfer system and an image forming apparatus incorporating the other transfer system in which primary transfer nips are formed by respective photoconductive members, an intermediate transfer belt **21**, and primary transfer rollers **25**C to **25**K, while toner images T are conveyed therethrough. Further, the image forming apparatus can be a monochrome type rather that a full-color type as described above.

Although the cams engage and disengage with the secondary transfer roller **30** to adjust a gap X between the belt surface of the intermediate transfer belt **21** and the surface **30***a* of the secondary transfer roller **30** as described above, the secondary transfer opposed roller **24** can engage and disengage with the secondary transfer roller **30** by disposing the cams **50** and **51**, a supporting mechanism supporting the cams, and a cam driving motor in the secondary transfer roller **30**.

Instead of the secondary transfer opposed roller **24**, the secondary transfer bias can be supplied from the high voltage power source **61** to the secondary transfer roller **30**.

Numerous additional modifications and variations of the present invention are possible in latent image of the above-described teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise that as specifically described herein.

What is claimed is:

1. An image transfer system comprising:

an image bearer to bear an image to be transferred onto a recording medium;

an opposed member opposed to the image bearer to form a transfer nip therebetween, said opposed member having a contact surface contacting the recording medium at the transfer nip;

a pressing device to apply pressure to the transfer nip;

an engaging and disengaging device to engage and disengage the contact surface of the opposed member from a surface of the image bearer; and

a transfer bias device to apply an image transfer bias transferring the image from the image bearer to the recording medium conveyed and pinched at the transfer nip,

wherein said engaging and disengaging device disengages the contact surface of the opposed member from the surface of the image bearer to make a gap therebetween when an adjustment pattern is formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip and passes therethrough,

wherein said transfer bias device applies a different bias than the image transfer bias between the image bearer and opposed member when the adjustment pattern passes therebetween,

wherein said engaging and disengaging device includes:

a cam having at least two different diameter portions changing a size of the gap when rotated;

a cam driving device to rotate and stop the cam; and

a cam controller to control the cam driving device, said cam controller controls the cam driving device to rotate and stop the cam at a first rotation angular position minimizing the gap when the adjustment pattern passes therethrough.

2. The image transfer system as claimed in claim **1**, further comprising a bias controller to control the transfer bias device, wherein said bias controller instructs the transfer bias device to stop applying the transfer bias when the adjustment pattern passes therethrough.

3. The image transfer device as claimed in claim **2**, wherein said transfer bias is turned on and off synchronizing with the rotation of the cam.

4. The image transfer system as claimed in claim **1**, further comprising a bias controller to control the transfer bias device, wherein said bias controller instructs the transfer bias device to apply a bias having a prescribed polarity to the transfer nip when the adjustment pattern passes therethrough, said polarity being opposite to that of an image transfer bias applied when an image is transferred onto the recording medium.

5. The image transfer device as claimed in claim **4**, wherein an absolute value of said opposite bias is smaller than that of the image transfer bias.

6. The image transfer device as claimed in claim **1**, wherein said gap is broadened repelling the opposed member against the pressure by rotating and stopping the cam at a second rotation angular position before exit of a trailing end of a former recording medium passing through the transfer nip therefrom.

7. The image transfer device as claimed in claim **1**, wherein said gap is narrowed by rotating and stopping the cam at a third rotation angular position before entrance of a leading end of the subsequent recording medium into the transfer nip.

8. An image transfer system comprising:

an image bearer to bear an image to be transferred onto a recording medium;

an opposed member opposed to the image bearer to form a transfer nip therebetween, said opposed member having a contact surface contacting the recording medium at the transfer nip;

a pressing device to apply pressure to the transfer nip;

an engaging and disengaging device to engage and disengage the contact surface of the opposed member from a surface of the image bearer; and

a transfer bias device to apply an image transfer bias transferring the image from the image bearer to the recording medium conveyed and pinched at the transfer nip,

wherein said engaging and disengaging device disengages the contact surface of the opposed member from the surface of the image bearer to make a gap therebetween when an adjustment pattern is formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip and passes therethrough,

wherein said transfer bias device applies a different bias than the image transfer bias between the image bearer and opposed member when the adjustment pattern passes therebetween,

wherein said engaging and disengaging device includes:

a cam having at least two different cam portions changing a size of the gap when rotated;

a cam driving device to rotate and stop the cam; and

a cam controller to control the cam driving device, said cam controller controlling the cam driving device to rotate and stop the cam at a prescribed rotation angular position changing the gap in accordance with a thickness of the recording medium, and wherein the image transfer system further includes a bias controller to control the transfer bias device, said bias controller controlling the transfer bias device to stop applying the bias when the cam is rotated and stops at a prescribed rotation angular position broadening the gap and the adjustment pattern passes therethrough.

9. The image transfer device as claimed in claim **8**, wherein said gap is broadened by rotating and stopping the cam at a second rotation angular position repelling the opposed member against the bias force before exit of a trailing end of a former recording medium from the transfer nip.

10. The image transfer device as claimed in claim **8**, wherein said gap is narrowed by stopping the cam at a second rotation angular position before entrance of a leading end of the subsequent recording medium into the transfer nip.

11. The image transfer device as claimed in claim **8**, wherein the transfer bias is switched synchronizing with rotation of the cam.

12. An image transfer system comprising:

an image bearer to bear an image to be transferred onto a recording medium;

an opposed member opposed to the image bearer to form a transfer nip therebetween, said opposed member having a contact surface contacting the recording medium at the transfer nip;

a pressing device to apply pressure to the transfer nip;

an engaging and disengaging device to engage and disengage the contact surface of the opposed member from a surface of the image bearer; and

a transfer bias device to apply an image transfer bias transferring the image from the image bearer to the recording medium conveyed and pinched at the transfer nip,

wherein said engaging and disengaging device disengages the contact surface of the opposed member from the surface of the image bearer to make a gap therebetween when an adjustment pattern is formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip and passes therethrough,

wherein said transfer bias device applies a different bias than the image transfer bias between the image bearer and opposed member when the adjustment pattern passes therebetween,

wherein said engaging and disengaging device includes:

a cam having at least two different cam portions changing a size of the gap when rotated;

a cam driving device to rotate and stop the cam; and

a cam controller to control the cam driving device, said cam controller controlling the cam driving device to rotate and stop the cam at a prescribed rotation angular position changing the gap in accordance with a thickness of the recording medium, and

wherein the image transfer system further includes a bias controller to control the transfer device, said bias controller controlling the transfer bias device to apply a bias having an opposite polarity to that of an image transfer bias applied for transferring an image onto the recording medium when the cam is rotated and stops at a prescribed rotation angular position broadening the gap and the adjustment pattern passes therethrough.

13. The image transfer device as claimed in claim **12**, wherein an absolute value of said opposite bias is smaller than that of the image transfer bias.

14. An image forming apparatus including an image transfer system, said image transfer system comprising:

an image bearer to bear an image;

an opposed member having a contact surface contacting a recording medium, said opposed member being opposed to a surface of the image bearer and forming a transfer nip therebetween;

a biasing device to apply a biasing force to the transfer nip;

an engaging and disengaging member to engage and disengage the contact surface from the surface of the image bearer;

a transfer bias device to apply transfer bias transferring an image formed on the image bearer onto the recording medium conveyed and pinched at the transfer nip,

wherein said image is composed of an adjustment pattern formed on a portion of the image bearer corresponding to an interval between recording mediums successively conveyed through the transfer nip, said engaging and disengaging device disengaging the contact surface from the surface of the image bearer to form a gap therebetween when the adjustment pattern passes therethrough, and

wherein the engaging and disengaging member includes:

a cam having a first cam portion which forms a first gap between the image bearer and the contact surface, and a second cam portion which forms a second gap between the image bearer and the contact surface, the second gap being smaller than the first gap;

a cam driving device to rotate and stop the cam; and

a cam controller to control the cam driving device such that when the adjustment pattern is not formed in between the recording media successively conveyed through the transfer nip, the first gap is formed between the image bearer and the contact surface, and when the adjustment pattern is formed on the portion of the image bearer corresponding to the interval in between the recording media successively conveyed through the transfer nip, the second gap is formed between the image bearer and the contact surface.

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